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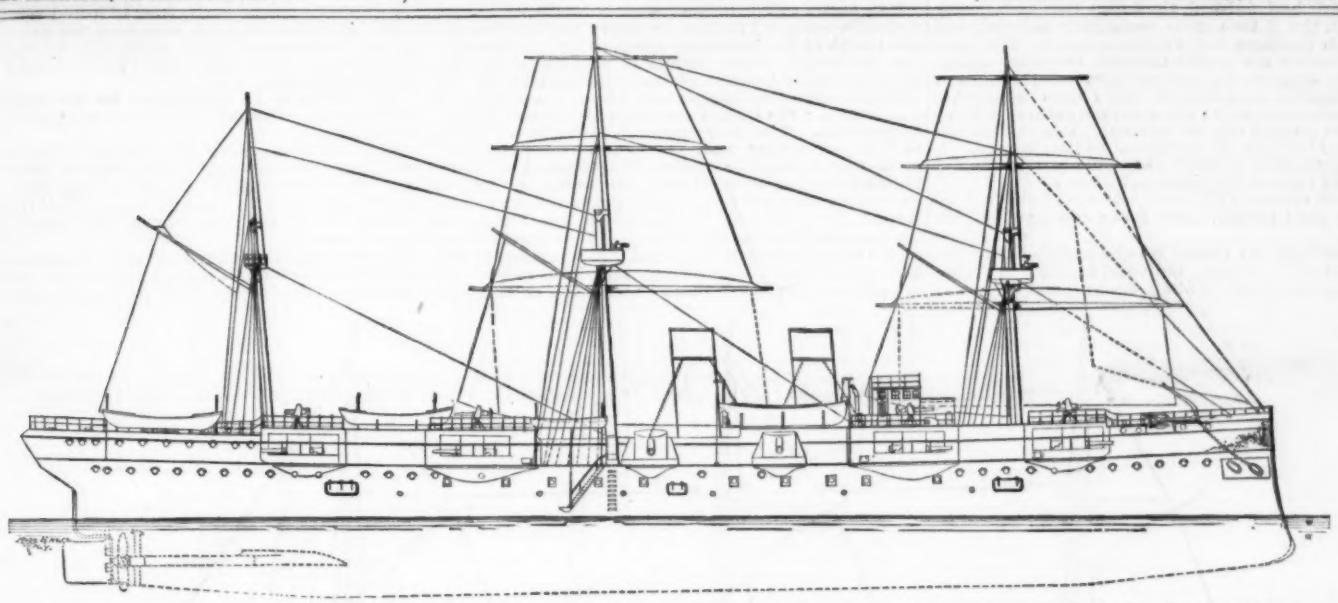
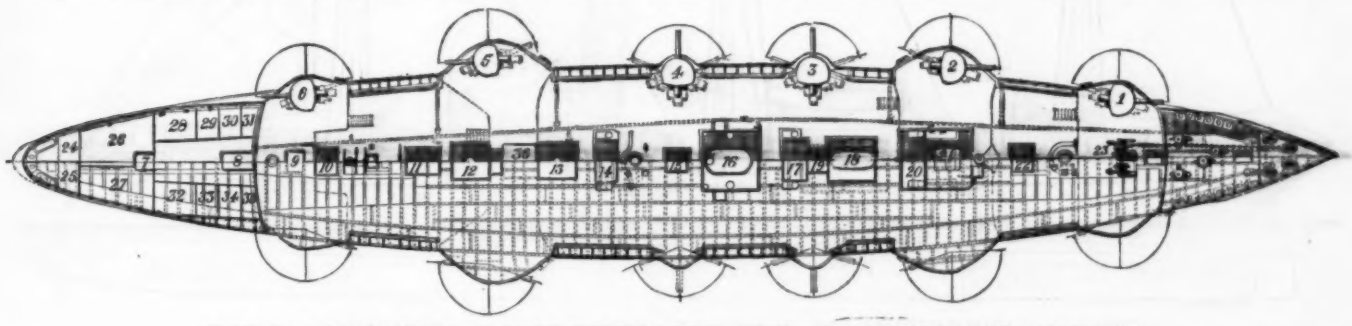
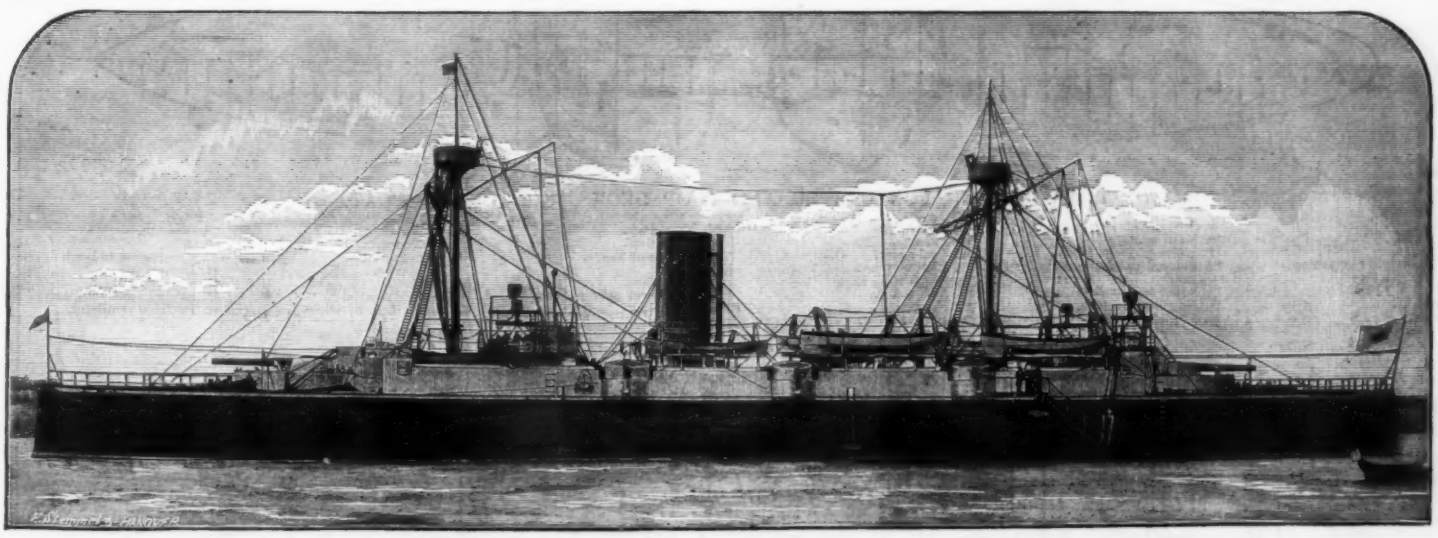


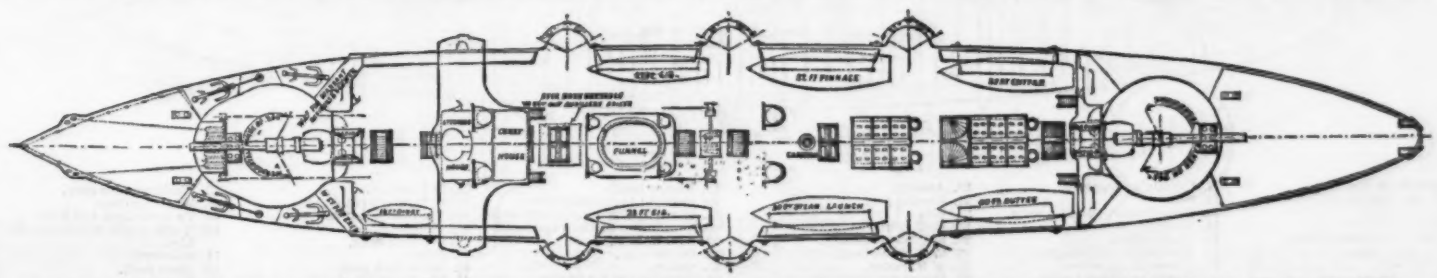
U. S. TWIN SCREW STEEL CRUISER, 4,000 TONS, RECENTLY AUTHORIZED BY CONGRESS.



PLAN OF GUN DECK U. S. TWIN SCREW STEEL CRUISER, 4,000 TONS DISPLACEMENT.

1. VI. in. B. L. R.
2. VI. in. B. L. R.
3. VI. in. B. L. R.
4. VI. in. B. L. R.
5. VI. in. B. L. R.
6. VI. in. B. L. R.
7. Skylight well to wardroom.
8. Skylight well to wardroom.
9. Skylight well to wardroom.
10. To wardroom.
11. To steerage and berth deck.
12. Engine hatch.
13. Engine hatch.
14. Fire room.
15. Ventilating hatch.
16. Smoke pipe.
17. To fire room.
18. Smoke pipe.
19. To berth deck.
20. To fire room.
21. Galley.
22. To berth deck Hotchkiss am.
23. Windlass engine.
24. Admiral's lavatory and smoking room.
25. Captain's lavatory and smoking room.
26. Admiral's cabin.
27. Captain's cabin.
28. Admiral's stateroom.
29. Admiral's office.
30. Admiral's pantry.
31. Executive officer's office.
32. Captain's stateroom.
33. Captain's office.
34. Captain's pantry.
35. Armory.
36. Chart house.





PROPOSED U. S. TWIN SCREW STEEL CRUISER, 3,730 TONS, TO BE CONSTRUCTED FROM THE DESIGNS OF MR. W. H. WHITE.

NEW AMERICAN WAR SHIPS.

THE new vessels heretofore authorized are the Dolphin, Atlanta, Boston, and Chicago, all of which are in progress, and will be completed within a few months. The *Army and Navy Journal* says: The armament of the Atlanta is nearly complete, and in two months she will be ready for sea so far as the Ordnance Bureau is concerned. The 6 inch guns for the Boston are finished, except sighting, and her 6 inch carriages are finished. The 8 inch guns and carriages for this vessel are three-fourths finished; all cast-iron projectiles partly finished; the powder is being made; her ordnance equipment is well under way, and her secondary battery guns and ammunition are mostly delivered. Work has commenced on her mounts, her electrical outfit is delivered, and the ordnance outfit can be completed in five months. The 6 inch guns for the Chicago are half finished, the 6 inch carriages nearly completed, the 8 inch guns one-eighth finished, and the 8 inch carriages not yet commenced. The cast-iron projectiles are partly finished, ordnance equipment just commenced, and secondary battery, guns, and ammunition all delivered. Work upon her mounts has not yet commenced; the electrical outfit is delivered, and the powder not yet ordered. Ten months will be required to finish the armament of the Chicago.

The construction of four additional vessels was authorized by the last Congress, as follows:

One steel cruiser, 4,000 tons; one steel cruiser, 3,730 tons; one steel cruiser, 1,700 tons; one gunboat, 870 tons.

The new 3,730 ton cruiser is to be modeled after the Japanese cruiser Naniwa, built and finished this year in England, after Mr. White's designs, and supposed to be one of the fastest, most effective, and formidable war vessels afloat. We give engravings of all four of these newly authorized vessels, taken from the official plans as prepared for the consideration of Congress, except the Naniwa, the cuts of which are from our own SUPPLEMENT of June 26 last, where a full description will be found.

Four Thousand Ton Steel Cruiser.—Dimensions: Length on load-line, 310 feet; beam, extreme, 49 ft. 1⅝ in.; draught, mean, 18 ft. 9 in.; load displacement, about 4,000 tons.

I. H. P., 6,000 natural draught; 8,500 forced combustion. Twin screws. Speed, estimated, 18 knots. Rig, bark. Plain sail area, 12,000 square feet. Coal capacity, 850 tons. Complement of men, 300.

Main battery: 12 6 in. breech-loading rifles.

Secondary battery: 4 47 mm. revolvers; 4 57 mm. H. P. single shot; 2 37 mm. revolvers; 1 short Gatling.

This vessel will be built of steel throughout, having a double bottom 3 ft. 3 in. in depth running the entire length of the machinery space, or 129 ft. Throughout the length of the double bottom the ship is constructed on the bracket system; before and abaft the double bottom the framing is of Z-bars, 6 in. × 3½ in. × 3 in. × 14 lb.; the frames are spaced 3 ft. from centers throughout. The outer plating varies from 17½ lb. to 15 lb. per square foot. The machinery, magazines, shell rooms, torpedo rooms, and steering gear are placed below an armored deck, which is 3 in. thick on its sloping sides and 2 in. on the horizontal part amidships. The outer edge of this deck is 4 ft. 3 in. below the load-line, sloping up to 15 in. above the load-line at the midship part of the vessel. All openings in this deck to machinery spaces, magazines, shell rooms, etc., are protected by coffer-dams. About 4 ft. at its lowest part above this protective deck runs a berth deck the entire length of the vessel; between these two decks, for the length of the machinery space, coal is stored, forming a belt of coal 15 ft. 6 in. in width above the machinery, while below the protective deck a belt of coal 9 ft. in thickness also runs the length of the machinery. The vessel is a poop and forecastle deck ship, with open gun deck. The battery will be mounted in sponsons on central pivot carriages supporting segmental shields 2 in. in. thickness—2 under the forecastle, 2 under the poop, 4 under the main bridges, and the balance amidships. Four guns will be able to concentrate within 400 ft. of bow or stern; either broadside of 6 guns will concentrate within 100 ft. of the ship's side.

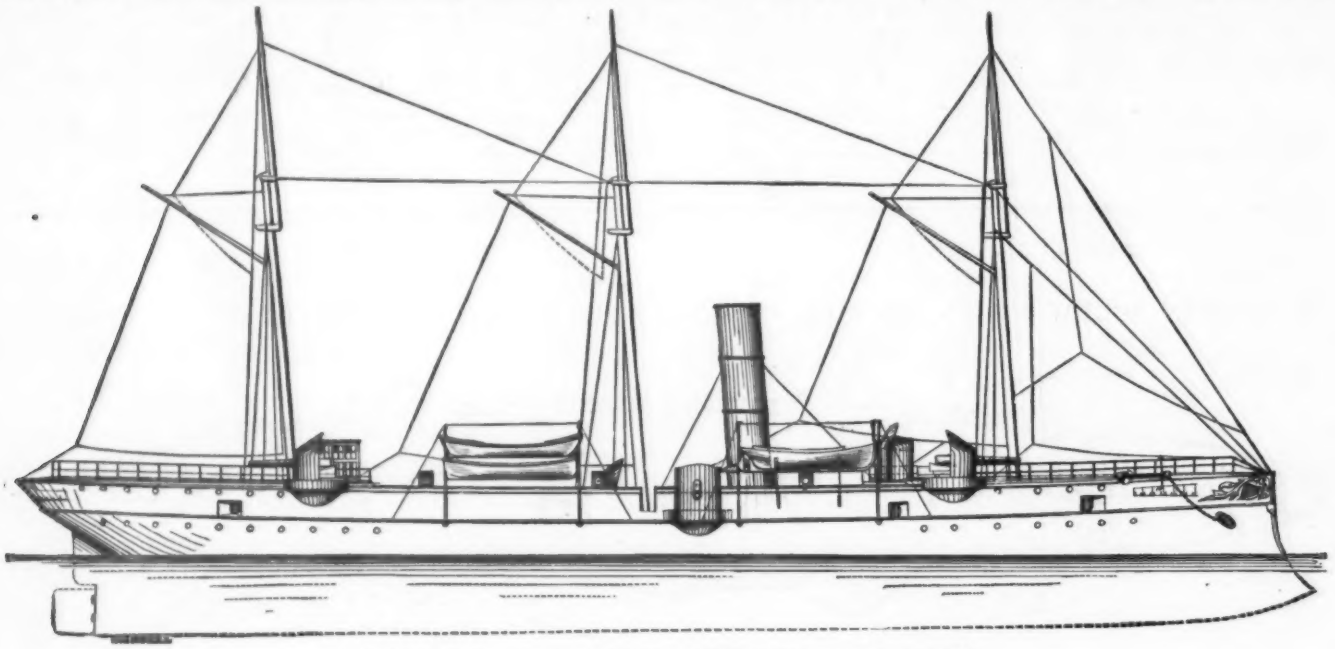
The vessel will be provided with six above-water torpedo-launching tubes, as in the 1,700 ton vessel; also electric search lights and apparatus for lighting the ship, also a complete system of forced ventilation.

The protective deck will be carried down to strengthen the ram-shaped bow, which will be thoroughly stiffened and strengthened by bulkheads and breast-hooks for ramming purposes.

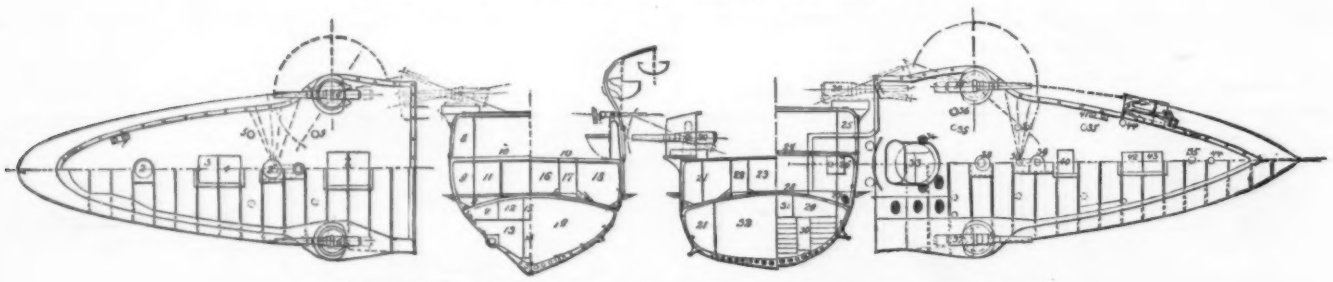
The hull will be subdivided by fore-and-aft and athwartship bulkheads into over 150 water-tight compartments.

3,730 *ton Twin Screw Steel Cruiser.*—We reproduce here the cut of the Japanese ironclad which represents this vessel. Principal dimensions: length between perpendiculars, 300 ft; moulded breadth, 46 ft.; draught forward, 17 ft. 6 in.; draught aft, 19ft. 6 in.; displacement, 3,730 tons.

The hull is constructed of steel throughout, with double bottom under engines and boilers, and a steel protective deck, two to three in. thick, complete from

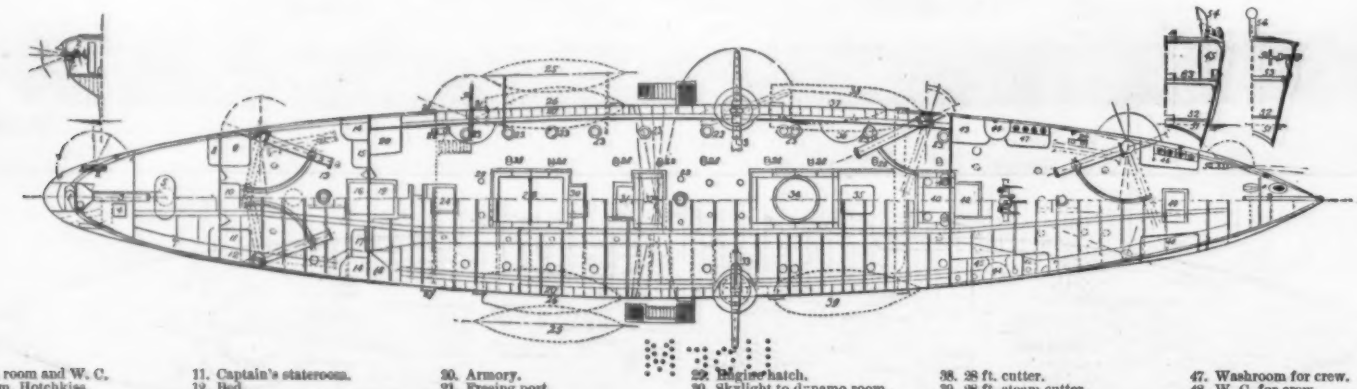


PROPOSED U. S. STEEL CRUISER, 1,700 TONS.



PLAN OF SPAR, FORECASTLE, AND POOP DECKS, 1,700 TON GUNBOAT.

1. Bitt.
2. Skylight.
3. Skylight.
4. Skylight and companion.
5. Deck light.
6. 6 inch B. L. R.
7. Skylight.
8. Stores.
9. Steerage stores.
10. Main deck.
11. Steerage.
12. Passage to small arm ammunition.
13. Small arm ammunition.
14. Magazine passage.
15. Torpedo heads.
16. Steerage pantry.
17. Passage.
18. Coal space.
19. Engine room.
20. 6 inch B. L. R.
21. Coal space.
22. Passage.
23. Blower room.
24. Main deck.
25. Wash deck.
26. Navigator stores.
27. Water.
28. Berth deck.
29. Small arm ammunition.
30. Magazine.
31. Chain.
32. Boiler room.
33. Conning tower.
34. Ventilator.
35. Deck light.
36. Passing scuttle.
37. 6 inch B. L. R.
38. Capstan.
39. Mast.
40. Companion to berth deck.
41. Bitt.
42. Skylight.
43. Skylight and companion.
44. Portable ventilator.



1. Bath room and W. C.
2. 37 mm. Hotchkiss.
3. Torpedo tube.
4. To cabin stores.
5. Table in captain's cabin.
7. Portable sofa.
8. Sideboard.
9. Cabin pantry.
10. Wardroom skylight.
11. Captain's stateroom.
12. Bed.
13. Torpedo manipulating room.
14. Stores.
15. Chart locker.
16. Wardroom companion.
17. Chronometer locker.
18. Executive officer's office.
19. Steerage companion.
20. Armory.
21. Freeing port.
22. Bitt.
23. Coal boat.
24. Skylight to pantry.
25. 27 ft. whaleboat.
26. 26 ft. cutter.
27. Hammock berthings.
28. Deck light.
29. Engine hatch.
30. Skylight to dynamo room.
31. Hatch to dynamo and berth deck.
32. Ventilating hatch to fire room.
33. 6 in. B. L. R.
34. Smoke pipe.
35. Galley.
36. Extra mount for 57 mm.
37. 18 ft. dinghy.
38. 28 ft. cutter.
39. 28 ft. steam cutter.
40. Ventilating hatch.
41. Ventilator.
42. To berth deck.
43. Prison.
44. Wash deck gear.
45. Wardroom W. C.
46. Steerage W. C. and washroom.
47. Washroom for crew.
48. W. C. for crew.
49. To berth deck and hold.
50. 57 and 47 mm. single-shot Hotchkiss.
51. Sailroom.
52. Berth deck.
53. Main deck.
54. Portable.

the ram to the sternpost, its edges 4 ft. below and its crown 1 ft. above the load water-line. Ten complete transverse and several partial bulkheads divide the hold into many water-tight compartments. The space between the protective deck and the main deck is very minutely subdivided into water-tight compartments occupied as coal bunkers, storerooms, chain-lockers, and torpedo rooms. The conning tower is protected by 2 in. of steel armor, and two ammunition hoists, 3 in. thick, lead direct from the shell rooms to the loading towers at the breech of the 10 in. guns. The freeboard is 15 ft., and the axes of the broadside guns are 18·2 ft. above the load water-line.

The armament consists of two 10 in. 28 ton B. L. R. on central pivots, the hydraulic revolving and loading gear and the recoil cylinders being protected by 2 in. steel screens and six 6 in. 4 ton B. L. R. on central pivot carriages, and spar deck sponsons in broadside. The secondary battery includes two 6 pounder R. F., eight 1 in. Nordenfelt, and four Gardner machine guns.

The torpedo battery consists of four launching tubes mounted above water in broadside.

The hydraulic power which actuates the gun mechanism is the same as that which operates the steering gear, and the 10 in. guns can be fired at point blank in a fore-and-aft direction without damage to the deck below.

The engines are of a horizontal (or slightly inclined) compound type, situated in two separate compartmens, one abaft the other, actuating three-bladed twin screws. I. H. P., under the forced draught, 7,650; maximum trial speed, 18·9 knots, the mean of two runs over a 10 mile course at load draught.

There are six single-ended locomotive three-furnace boilers in two separate compartments with athwartship firerooms.

This ship has two military masts, no sail power except storm sails; her normal coal capacity is 450 tons, but 800 tons can be carried, which increases her draught 1 ft. 6 in.; her endurance at 10 knots is about 8,600 miles, and at 8 knots about 11,000 miles, and her complement is 325 officers and men.

Seventeen Hundred Ton Gunboat. — Dimensions: Length on load-line, 230 ft.; beam, extreme, 36 ft.; mean draught, 14 ft.; load displacement, about 1,700 tons. Twin screws. I. H. P., 2,200 natural; 3,200 forced combustion. Speed, 16 knots. Rig, three-masted schooner. Plain sail area, 4,409 sq. ft. Coal capacity, 400 tons. Complement of men, 150. Main battery, 6 6 in. guns (breech-loading rifles); secondary battery, 2 57 mm. high-power, single shot, 2 47 mm. high-power, single shot; 2 37 mm. revolvers; 1 short Gatling. This vessel will be unsheathed, built of steel; the frames are Z-bars, 6 in.×3½ in.×3 in. 14 lb. The outer plating is of 14 lb. per sq. ft. The engines, boilers, magazines, shell room, and steering gear are placed beneath a water-tight steel deck, running the entire length of the vessel, ⅜ in. in thickness, its outer edge being 3 feet below the load water-line and rising to the load line at center line amidships. The stem will be slightly ram-shaped, and stiffened for ramming. The hull is divided into numerous water-tight compartments, as in the 870 ton. All openings in the water-tight deck to machinery and magazines are protected by coffer-dams; the machinery is further protected by a belt of coal 9 ft. in thickness, running entire length of the machinery space.

The main battery will be mounted in sponsons on central pivot carriages supporting segmental shields; two on the forecastle; two on the poop, and two amidships. The forward and after guns will be able to concentrate on an object 300 ft. from the pivots, while the admidship guns will have a train of seventy degrees abaft and forward of the beam. Three guns may be concentrated on either broadside within 100 ft. of the ship's side. This vessel will be provided with six above-water launching torpedo tubes, capable of being trained several degrees forward or abaft the beam; she will also have a fixed torpedo tube in the bow and stern; she will also be provided with electric light apparatus and search lights.

Eight Hundred and Seventy Ton Gunboat.—Dimensions: Length between perpendiculars, 175 ft.; beam (extreme), 31 ft.; draught (mean), 11 ft. 10 in.; displacement, about 870 tons.

I. H. P., 900 natural draught; with forced combustion, 1,350. Speed (estimated), 12 knots. Rig, barkentine. Plain sail area, 4,480 sq. ft. Cold capacity, 160 tons. Complement of men, 100. Number of screws, 1.

Main battery, 4 6 in. guns.

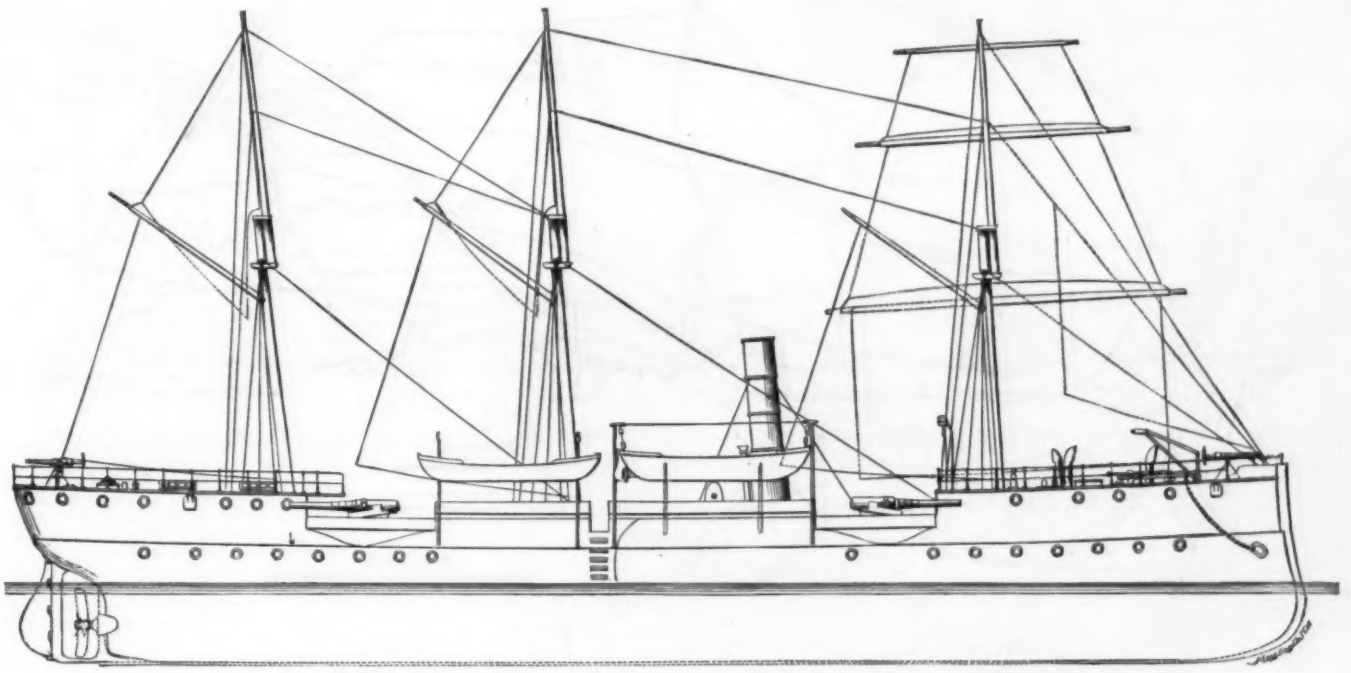
Secondary battery 2·47 mm. high power single shot; 2·37 mm. revolvers; 1 short Gatling.

This vessel will be constructed on the composite system, viz., frames, beams, stringers, and keelsons of steel, with the outer planking and decks of wood; the planking will be in two thicknesses of 2½ and 3 inches, and coppered.

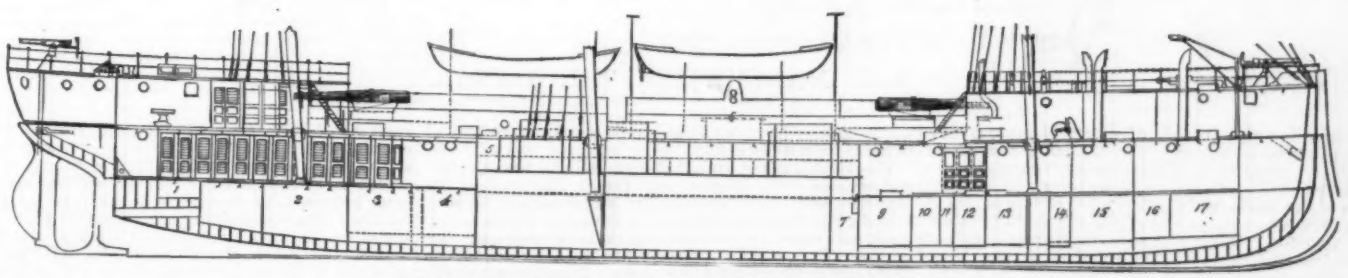
The engines and boilers are placed beneath a water-tight steel deck ⅜ in. in thickness, its outer edge being 27 in. below the water line, rising to 8 in. above at the center line amidships. The vessel is divided into numerous water-tight compartments by steel athwartship and fore-and-aft bulkheads, thus localizing the damage due to the hull being penetrated by shot or ramming.

The main battery will be mounted in sponsons on central pivot carriages, two having a range of from 2 deg. across the bow to 70 degs. abaft the beam, and two having a range of from 2 degs. across the stern to 70 degs. abaft the beam, and two having a range of from 2 degs. across the stern to 70 degs. forward the beam. Two guns can be concentrated on an object 400 ft. ahead of the bow, or abaft the stern.

The engines, like those of the 4,000 cruiser, will be placed in separate water-tight compartments, and will be duplicates. The propellers are to be three-bladed,

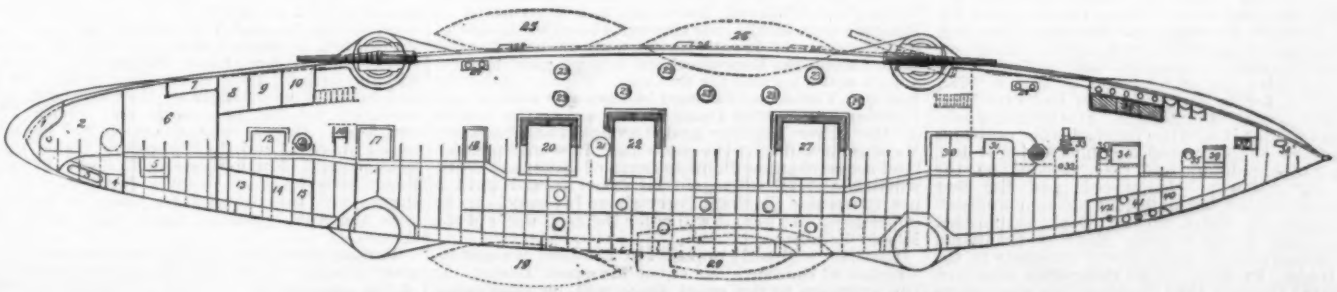


PROPOSED U. S. COMPOSITE GUNBOAT, 870 TONS.



PROFILE INBOARD 870 TON COMPOSITE GUNBOAT.

1. W. R. stores.
2. Bread room, port side.
3. Shell room, port side, magazine opposite.
4. Paymaster's stores, port side.
5. Engineer's stores.
6. Platform, portable.
7. Coal.
8. Light box.
9. Magazine.
10. Hold.
11. Water tank.
12. Shell room.
13. Fixed ammunition.
14. Chain locker.
15. Sail room, port side, paymaster's stores, S. side.
16. Navigator's stores, port side; hospital stores, S. side.
17. General stores.



SPAR DECK PLAN 870 TON COMPOSITE GUNBOAT.

1. Transom sofa.
2. After cabin.
3. Bath.
4. W. C.
5. To cabin stores.
6. Cabin.
7. Portable sofa.
8. Cabin pantry.
9. Chart room.
10. Paymaster's office.
11. Mast.
12. Wardroom skylight.
13. Captain's stateroom.
14. Captain's office.
15. Armory.
16. Steering wheel.
17. Wardroom companion.
18. Steerage companion.
19. 27 ft. gig whaleboat.
20. Engine hatch.
21. Mast.
22. To fireroom.
23. Coal chute.
24. Bitt.
25. 27 ft. whaleboat.
26. 37 mm. rev. cannon, same opp.
27. Chimney.
28. Freeing ports.
29. Boat.
30. To berth deck.
31. Galley.
32. Chain pipe.
33. Steam windlass.
34. To berth deck.
35. Vent.
36. W. C. for crew.
37. Nipper.
38. Manager.
39. Scuttle.
40. Officers' urinal.
41. Washroom.
42. W. C.

of about 11½ ft. in diameter, and will be made of manganese bronze.

The boilers will be four in number, of horizontal, cylindrical, tubular type, containing an aggregate grate area of 240 square feet, arranged fore and aft in two water-tight compartments, with a fire room athwartship, abaft the after boilers and forward of the forward boilers. All the steering engines, windlasses, and capstans and other auxiliary machinery are to be of latest improved pattern.

The machinery of the 870 ton gunboat is designed to have, with its auxiliaries, 1,300 I. H. P. under forced draught.

The engine is to have a high and a low pressure cylinder of 25 and 46 in. diameter, respectively, and a stroke of 33 in., and the number of revolutions to be about 136 per minute. The propeller will have three adjustable blades, with a diameter of 9 ft. 9 in., and to be capable of adjustment as to pitch.

The boilers are to be two cylindrical boilers, 18 ft. 8 in. long and 8 ft. 8 in. diameter, and contain an aggregate of 93 square feet, and a heating surface of about 2,733 square feet. They are to be placed side by side forward of the engine, with an athwartship fireroom 8 ft. 6 in. wide.

THE MANCHESTER SHIP CANAL.

After four years of untiring activity and resistance to ceaseless opposition, the promoters of the Manchester Ship Canal have brought the gigantic undertaking, which will convert Manchester into a seaport, and revolutionize the carrying trade of the busiest area of the United Kingdom, to a satisfactory issue. Very shortly the financial details of the project will be laid before the public, and substantial guarantees have been obtained that, in four years from the date of commencing the work, the canal between Manchester and the sea will be open for the transit of ocean steamers. We have on previous occasions—in fact, during the whole course of the protracted Parliamentary struggle—devoted considerable space to describing the general features of the work, which were more or less modified year by year, to meet the objections successfully raised by its opponents. Our readers are therefore conversant with all the leading facts connected with the Manchester Ship Canal, which may, however, be conveniently summarized now that the scheme is about to be put in execution. The idea of converting Manchester into a seaport is a very old one. So long ago as 1832, the ease with which such a scheme could be carried out, and the enormous advantages which would follow its completion, naturally attracted the attention of engineers, and, among others, Mr. Hawkshaw, then engineer to the Manchester and Bolton Railway, and Mr. Fairbairn strongly advocated it. But with the new railway era, canal construction was rapidly falling out of favor, and the scheme was abandoned and practically forgotten till Mr. Daniel Adamson, in 1881 or 1882, revived it on a far larger scale than had ever been dreamed of by the earlier engineers. It is not too much, perhaps, to say that it is to the indefatigable exertions of Mr. Adamson the success of the undertaking is due. As soon as a plan of action had been decided on, the necessary surveys were commenced, and the first Parliamentary contest began in 1883, strenuous opposition being made by the Liverpool Dock authorities, the London and North-Western Railway Company, and other bodies having large vested interests in the carrying trade. In spite of all difficulties, however, the bill passed through the Commons', but was thrown out by the Lords' Committee. Returned to Parliament in 1884, the measure was again defeated, chiefly on account of the alleged interference with the Mersey estuary, as the canal was then laid out to pass through the center of the estuary, which is obstructed by ever-shifting sandbanks. This time the measure passed through the Lords', but was rejected by the Commons' Committee, and for the third time the untiring promoters appeared with their project last year, modified as shown upon the plan we publish on this page. From this plan it will be seen that the last tenable objection was removed, as the canal skirts the southern shore of the Mersey estuary, suitable provision being made to accommodate the Weaver Navigation, that makes its exit near Frodsham. On this occasion the canal promoters were signally triumphant, and obtained their bill at last, after having brought it successfully through four committees out of six. Such a prolonged and keenly contested struggle was of course enormously costly, not much short of 350,000*l.* having been spent in defending and attacking the measure. The expenses of the Canal Company were 146,000*l.*, which was raised by public subscription—almost wholly in and around Manchester. This year the company again had to come to Parliament for sanction to pay interest out of capital during the time of construction, and they are now empowered to pay such interest at the rate of 4 per cent. per annum for the period of four years that the works are to be under construction.

By the act which received the royal assent on August 6, 1885, the Manchester Ship Canal Company was incorporated for two principal objects: The construction of a canal navigable by vessels of the largest capacity between the deep water of the Mersey estuary at Eastham on the opposite bank of the river to Liverpool and Manchester, and for the acquisition of the entire interest of the Bridgewater Navigation Company.

The purchase of the undertakings of the Bridgewater Navigation Company is fixed by the act at 1,710,000*l.*, and the deposit required to be paid into the Bank of England as an earnest of the completion of the bargain was made on February 2, 1885. This purchase of the Bridgewater undertakings is the inevitable corollary of the prime object, as some of their properties are required for the purposes of the ship canal. These undertakings have for some years paid a dividend of not less than 8 per cent.

The Bridgewater undertakings include the Bridgewater Canals, the Mersey and Irwell Navigation, the Runcorn and Latchford and the Runcorn and Weston Canals, the Runcorn Docks, the Duke's Dock in Liverpool, and extensive warehouses in Liverpool and elsewhere. The whole interests are transferred to the Manchester Ship Canal Company. The ship canal will be practically one continuous dock, 35 miles in length, 26 ft. deep, and 120 ft. wide at the bottom, almost any portion of its banks being capable of conversion into wharfage accommodation. It will commence at a point on the River Irwell (see plan, above) about one mile from the Manchester Royal Exchange, and proceeding *via* Barton-upon-Irwell, Irlam, Partington, Hollingford, Thelwall, Latchford, and Warrington to Runcorn Gap, it will pass through the outer basins of the Mersey and Irwell Navigation, to be extended thence along the Runcorn shore, widening out to form a dock and wharving for Runcorn. Passing under the Runcorn Viaduct and alongside the outer walls of the Runcorn and Weston Point Docks, across the mouth of the River Weaver and through the Frodsham Marshes, it will skirt the shore near Ince and pass inland across Stanlow Point in front of Ellesmere Port, where the canal will again be taken inland until it nearly reaches Eastham Ferry above Liverpool on the opposite shore; here it will enter the deep water of the Mersey Estuary.

Eastham is directly opposite to the port of Garston, which is at the south end of the Liverpool Docks. At the entrance to the canal there will be tidal gates, which at low water will be worked as locks. Large vessels will be able to enter or leave the canal at almost any state of the tide, instead of only during forty minutes of each tide as at Liverpool.

It is considered that vessels will be able to navigate the canal with ease and safety at a speed of five miles per hour. At this speed the journey from the entrance to the docks at Manchester would occupy from eight to ten hours, including the time required for the passage of the locks.

The canal will be lighted by the electric light, and so buoyed as to enable vessels to pass up and down at any hour. The ascent to the level of the docks in Manchester, which is 60 ft. 6 in. above the level of the ordinary tidal portions of the canal, will be made by means of four sets of locks as follows:

		Ft.	In.	
Latchford locks	.....	16	6	rise.
Irlam "	.....	14	0	"
Barton "	.....	14	0	"
Entrance "	to Manchester docks	16	0	"
		60	6	

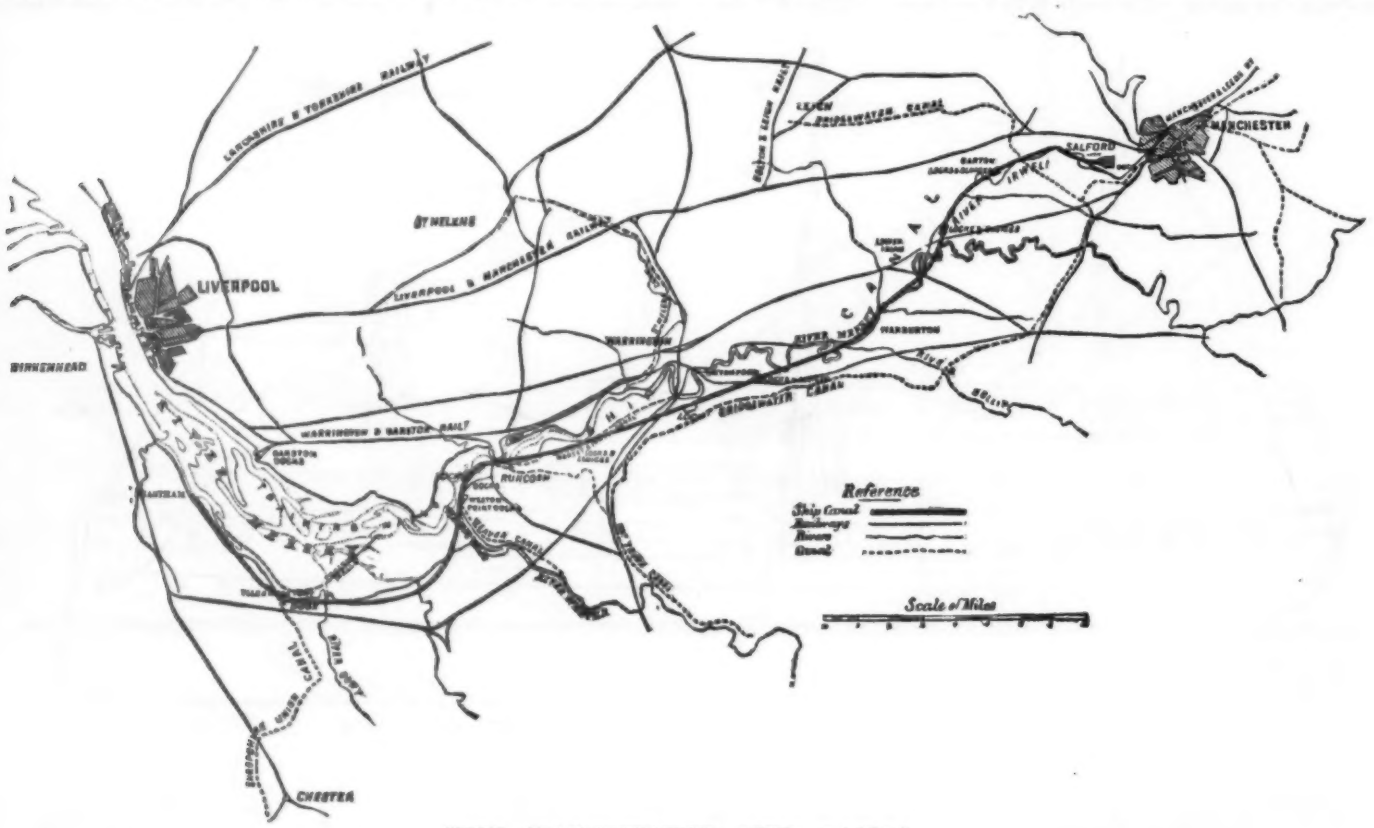
These locks will divide the canal into four reaches, the individual lengths of which are as follows:

	Miles.	Fur.
From Eastham to Latchford.....	20	6
" Latchford to Irlam.....	7	3
" Irlam to Barton.....	2	6
" Barton to Manchester docks.....	4	0
	34	7

The locks will be of such capacity as to admit the largest merchant vessels afloat, and are also arranged to accommodate small craft. Each set will comprise three locks as follows, all capable of being worked simultaneously: 1. A large lock, 550 ft. by 60 ft. 2. An intermediate lock, 300 ft. by 40 ft. 3. A small lock, 100 ft. by 20 ft. These locks are respectively adapted for ships of the largest size, for vessels of smaller tonnage, and for coasters and barges. Each set of locks can be worked independently by hydraulic power, enabling vessels to be passed up or down in 15 minutes. At each set of locks there will be flood sluices with clear opening of from 120 ft. to 160 ft., which will rest on sills at the level of the bottom of the canal. The piers which carry these sluices will be sufficiently high to enable them to be raised above the level of the highest flood, thus preventing any obstruction to the passing of floods down the canal. Owing to the increased depth, the much straighter course, and the greater capacity of the new channel, floods will pass off at such a considerably diminished height as to be of great benefit to all owners and tenants of the adjacent property. Under ordinary circumstances, the water not used at the locks will flow over the tops of the sluices which will be closed; thus the sluices will form movable weirs.

Spacious docks, with a total water area of 85½ acres and four miles of wharfage, will be constructed at Manchester, Salford, and Warrington, and coal basins at Partington, to connect the canal with the railway system of the Cheshire Lines Committee; a branch line will also be built from Warrington to join the London and North-Western Railway, thus establishing accommodation for the Lancashire and South Yorkshire coal fields. Direct communication will be made between the canal and the Shropshire Union Canal and London and North-Western Railway at Ellesmere Port; with the River Weaver Navigation at Weston Point; with the Bridgewater Canal at Runcorn; and with the great system of canals that center at Manchester.

Turning now to the leading financial features of this great scheme, we find that the authorized share capital of the company is 8,000,000*l.*, of which 750,000*l.* have been already allotted. The public will therefore be asked by Messrs. N. M. Rothschild & Sons, who are acting as financiers for the company, to subscribe for 7,250,000*l.*, which, judging from the contract entered into with Messrs. Lucas & Aird, will be amply sufficient for all requirements. The estimate of the company's engineer, Mr. Leader Williams, for the canal



THE MANCHESTER SHIP CANAL.

works was 6,311,000*l.*, but Messrs. Lucas & Aird have undertaken to complete the whole works for 5,750,000*l.*, or a sum more than half a million under the engineer's estimate. The value of land that must be purchased for the canal is 802,000*l.*, and the sale price of the Bridgewater and Mersey and Irwell Canal systems is 1,710,000*l.* Besides this, the preliminary expenses, to be repaid to the subscribers in shares, amount to 146,000*l.*, bringing the total expenditure up to 8,408,000*l.* The total authorized capital is 9,812,000*l.*, so that only a comparatively small issue of preference stock can be made.

This is a gigantic undertaking, involving the expenditure of vast sums of money, but the traffic it will command when completed will be on the same large scale, and even at the moderate rates which the company are authorized to levy should not only—assuming the work to be carried out as anticipated—earn a good revenue, but must revive, stimulate, and even transform many industries drooping now under the burden of high tariffs for transport. The present cost of transferring a ton of goods from ship in Liverpool to railway station at Manchester varies from 9s. 5d. to 17s. 11d. The maximum canal charges for the same distance will range from 4s. 9d. to 7s. 9d. per ton. And, of course, corresponding economies, which mean in many cases the conversion of a loss in manufacture to a fair profit, will be effected in all the great centers of Lancashire and the adjoining counties. Stockport, Rochdale, Oldham, Huddersfield, Leeds, and scores of other towns will be relieved from the intolerable rates they have now to pay. No wonder vested interests fought hard against this scheme. The railway carrying companies between Liverpool and Manchester must fall entirely out of profitable competition, for whereas they now charge from 6s. 8d. to 10s. 10d. per ton from station to station, they will be obliged, if they maintain the traffic, to charge almost nominal and wholly unremunerative rates.

The amount of paying traffic that might at the present time be carried on the canal is 21,000,000 tons per annum, but the calculation of the company, both now and before the various committees, is based upon 3,000,000 tons yearly, carried at half the existing rates. These, with ship dues, and the net income of the Bridgewater Canal (60,000*l.*), would produce a revenue of 885,000*l.*, from which has to be deducted the sum of 176,000*l.*, the estimated cost of working; and a revenue sufficient to pay a dividend of more than 7 per cent. on the capital, with a large margin for a reserve fund, will be thus earned. Generally an uncertain element exists in such a calculation of results. There can be no doubt about the great tide of traffic that will set in as soon as the works are finished, and the allowance for working expenses is a sum which past experience can fix with certainty. The cost of the work is therefore the only item that is open to question. But the execution of this undertaking, great though it is, presents absolutely no engineering difficulties, the solutions of which would have to be made at the cost of the shareholder. The examination of the route has been so thorough, and the nature of the ground is so well known, that neither engineers nor contractors can fall into error; and we do not hesitate to say that the names of Mr. Leader Williams and Mr. Abernethy on the one hand, and of Messrs. Lucas & Aird on the other, leave no room for doubt that an exhaustive investigation on this vital point was made before the figures to be laid before the public were arrived at, and that the work will be fully completed for the agreed sum.

That the canal should form an investment more or less profitable is, however, a matter of minor importance compared with the revolution in trade that it will create. The railway companies concerned may suffer by the competition, but their loss will prove the gain of the greatest manufacturing center in the country, and a vigorous blow will be struck at the root of one of our greatest commercial evils—excessive carriage tariffs. It is not probable that Liverpool will find in the Manchester Ship Canal a dangerous antagonist. True, a large amount of traffic that now pauses to pay toll will be diverted into a more direct and profitable channel, but new and improved means of distribution are never found, in a country whose population and whose trade are always rapidly increasing, to damage existing interests. On the contrary, it is probable that when the district of which Manchester is the center shall possess its own seaport, the stimulus thus created will react upon Liverpool, and so far from emptying her docks and impoverishing her warehouses, it will bring a larger business to both by means of a general improvement in trade.—*Engineering.*

THE RECLAMATION OF LAKE COPAIS.

THE people who take any interest in the doings of Greece regard it as a plucky little state, striving its utmost, by warlike means and fierce language, to assert its rights to be regarded as the descendant of the great Greece of old, doing what it can to be worthy of the traditions handed down from father to son through many centuries of gloom and deadly oppression from the days of Pericles, of Alexander, of Socrates, and the poets; but there are not many among even the greatest friends of Greece who regard it as being a land in which works of considerable engineering magnitude are being carried out, and yet there is no doubt that the little kingdom of the Hellenes is advancing to a place of some importance, not only in the minds of all true Philhellenes, but in the estimation of such men as know it within and round its shores.

The Lake of Copais, or, as it is properly called in Greek, "Copaiba," is a great marshy basin, situated some miles inland from the channel which runs between the island of Egripos, or Negripont, and the mainland. It lies in the neighborhood of Thebes and Livadia, and is situated at a considerable height above the level of the sea. Its waters accumulate from the watersheds from the north, from the mountains of Parnassus and Helicon, and from the overflow from neighboring rivers during the winter or other wet seasons, collecting in the plain of Copais, and forming a huge lake of some 60,000 acres in extent. In each October this plain is only a marshy swamp; in November the water-level begins to rise, attaining its maximum height in April, then falling until it has reached its normal condition of being a dismal swamp in October, only to rise again with unerring regularity in November. The water, which rises during six months of the year, disappears during five other months from two causes, viz., evaporation and the existence of "katavothres." To the former of these causes is due the disappearance of a body of water of the whole area of the plain by about 5 ft. in thickness, and to the latter that of a still larger quantity. It may be mentioned that the katavothres are the geological fissures which exist all round the lake, but in the greatest number on the east side. Some of these katavothres lead to the sea, and a very large number of them to the depths of the earth. It will be readily understood that this great stagnant inland lake is a fruitful cause of sickness and malaria to all who come within the range of its evil influences; and that during the months of July, August, September, and October, the ravages from the fever within a distance of fifteen kilometers of its borders are very deadly. The soil of the plain under the water is of remarkable fertility, which it owes to the great quantity of organic matter which it contains, and would in a very short time repay the outlay required to dry it up, so that the promoters and movers in the scheme might expect to be reimbursed in a little time, while the sanitary effect on the country for miles round this present plague spot would be incalculable.

It is known that in the remote ages of antiquity the depth of water was much greater, and the evil effects from a health point of view were not nearly so serious; but things have changed greatly since then, and among many others volcanic causes have operated to raise the bed of the lake, with the effect of greatly augmenting its area, reducing its depth, and multiplying in an enormous degree its evil followings. It is evident from traces which have been found that the ancients made many attempts to rid themselves of this plague, but without any serious result, if we except the fact that the remains of the work have shown to the modern engineers the things they should avoid in many cases, and in many instances the work of the ancient has been of the utmost assistance to the modern engineer.

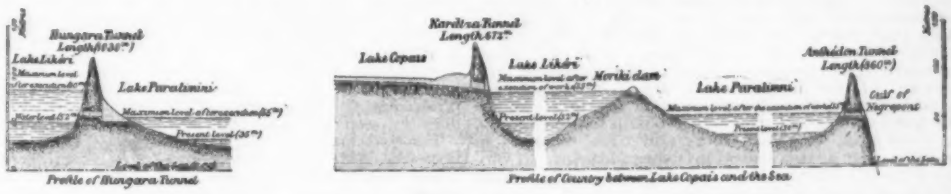
The first attempts to dry the lake made after modern methods date back to 1847, and were made by M. Sauvage, to whom much is owed as the pioneer of the work. His scheme was to overflow the lake through a tunnel pierced under the neck of Larymna, utilizing to a large extent many ancient works, which had evidently been used for a somewhat similar plan. It will be seen that, had this plan succeeded, it would have involved the loss of the water for agricultural purposes. After this the work was many times conceded by the Hellenic government, and to various companies and individuals; but from one cause or another, want of money or of energy, all the schemes came to grief, until two French engineers—M. Revol, engineer of bridges and dikes, and M. Moulle, civil engineer—took the matter in hand, proposing to allow the waters to run away through lakes Likeri and Paralimini, making Likeri a reservoir for irrigation during the summer, which scheme was really the parent of the work in its present form.

In 1880 a concession was given to M. Vouro, who, with the aid of one of the great merchants of Athens, M. Scoulondis, succeeded in forming a company, mainly French, which was intrusted to the management of M. Saratte, but unfortunately, just as this latter gentleman's projects were ripe for execution, he was overtaken by premature death, and was succeeded in 1882 by a M. Pochet, engineer of bridges and dikes, on whose plans the work was advanced to a very large degree; but in 1884 the company, at whose head was M. Scoulondis, took the whole of the work under its immediate supervision, with a result upon which it cannot be too heartily congratulated. The difficulties of great unhealthiness and distance from any victualing center were the greatest to be overcome.

The work now consisted of two parts: (1) The construction of canals proper; (2) the various lines of auxiliary canals, the function of which is to collect the water of the tributary rivers and the rain, and to lead these into the Bay of Karditya, from whence they should pass by the main canal and tunnel. There are three canals, which may be seen on reference to the accompanying map: (1) The great central canal, thirty-four kilometers in extent at present, which will follow the south bank of the lake; (2) the Melas canal, which will follow the north bank; and (3) the interior canal, which will collect the water from the lowest part of the interior of the marsh. These three canals will converge at Karditya, but the work of their construction cannot be vigorously pursued until the passage for the emission of the water at Karditya has been completed, that is to say, until the partial drying up of the lake has been accomplished. The water will pass through a canal and tunnel at Karditya, and will be led down to the sea through lakes Likeri (or Hylicus) and Paralimini.

The construction of the passage consists in the excavation of a deep and wide ditch or dike, and the formation of a tunnel 672 meters long to Karditya, which passage will lead the waters of Copais to Lake Likeri, whose level will be raised from 52 meters to 80 meters above that of the sea.

At Moriki there is a *deversoir* some 50 meters wide which will carry the overflow from Likeri to Lake Paralimini, the water in which will rise from a normal level of 36 meters to 55 meters above the level of the Gulf of Negropont, to which it will be conveyed by means of a tunnel 860 meters long, and which will debouch at Anthedon. It will be seen that the water from Paralimini to the sea will have a fall of 55 meters; and according to the estimate of the engineers, this fall will be able to yield no less than 12,000 horse-power, and will thus supply a reason for the establishment at Anthedon of a large industrial town, or it can be utiliz-



THE RECLAMATION OF LAKE COPAIS.

A FLOATING STEAM FIRE ENGINE.

THE Zophar Mills is the model fireboat of the world. On Dec. 19, 1882, her hull arrived here from Wilmington, Del., where she was built by Pusey & Jones. Here her pumps and other machinery were put in, and on April 1, 1883, she did her first work at a fire—the burning of the steamship City of Hudson. Since then she has been continuously in service.

The cost of the Zophar Mills complete was about $60,000. Her tonnage is about thirty tons greater than that of the W. F. Havemeyer, and her pumps being of the Clapp & Jones make, now in general use by the Fire Department, are said to be much more effective than those on the old boat. She is 125 feet in length over all, 25 feet breadth of beam, and has 9 feet depth of hold. The capacity of her main engine is 250 horse power, and her two pumping engines are 30 horse power each. With this power she can throw from each pump, when worked at the top of her ability, 1,400 gallons a minute.

Her ordinary service from both pumps working to-

gether is about 2,400 gallons a minute. That seems like an enormous quantity of water to throw at a fire. At that rate she must have thrown about 23,000,000 gallons on the Bank Street cotton fire during her 162 hours of work there. Capt. Farrell, speaking of the new governable nozzles now in use, which enable the throwing of an inch and a half stream or a quarter inch stream, or no stream at all, at the will of the fireman, said: "No, we have no nozzle of that kind aboard. When they call for us, they want water—all they can get of it." And those pumps seem to meet the want. It is curious, by the way, what a vast quantity of water is required to put out a fire among cotton. The only thorough way to stop cotton burning is to pick it all apart and soak it with water. The men who picked over the cotton that was in the Bank Street conflagration found fire still smouldering in it after the lapse of a month, and notwithstanding all the drenching it had received.

When the Zophar Mills was first put in service, her captain was C. D. Purroy, brother of Commissioner Purroy, and now one of the chiefs of battalions. He was succeeded by the present captain or foreman, Robert R. Farrell, formerly in command of the W. F. Havemeyer, whose lieutenant, or mate, or assistant foreman, is John Barber. It is not exactly clear what titles should appiy to the principal officers on the fireboat. Her force is upon record as Engine Company 51, but its organization is very different from anything on land.

With the officers named, there are eight firemen in uniform (one of them an engineer), two pilots, two ununiformed engineers, and three stokers. Their salaries run like those of land companies—$1,800 a year for the foreman, $1,500 for the assistant foreman, $1,400 for the engineer, $1,200 for the men, and $60 a month for the stokers. Except in case of short leaves of absence granted to individuals for some absolutely necessary business ashore, officers and men are on duty all the time, ready for instant service at any moment, day or night. They get their meals ashore, but the men sleep on board in a large square room on the main deck, just forward of the pumps, which are in an apartment amidships, and the officers' quarters are in rooms on the hurricane deck. The men's room is double bunked on three sides, with side doors and large windows in front, so that at this season it is very pleasant. In winter a steam heater makes it comfortable. In speaking of it as pleasant in summer, exceptions must be made for the nights when a gentle southerly and westerly breeze brings over myriads of New Jersey mosquitoes to the boat's station, which is at the foot of West Thirteenth Street, the westernmost point of the island. It is a very much exposed and exceedingly severe place in cold weather.

When the fireboat lies at her dock, her bow is pointed to the river in readiness to dart out, and all her connections with the shore are so arranged that they can be slipped, and she can be out in the stream within a minute after an alarm is sounded aboard. At the bow she is held by a doubled line with the bight aboard, so that it can be thrown off instantly; the telegraph and telephone cable has a metal plug on its shore end that slips into a socket in the back of a little house like a sentry box on the pier, and can be disconnected in a second; the stern line is hitched over a snubbing post on the pier, and can be cast loose by the man who breaks the cable connection, with a single motion. There is always a pressure of sixty pounds in the boilers, which is ample for immediate action.

A first alarm calls the fireboat to any point between Seventieth Street on the North River and Fourteenth Street on the East River, and a second alarm commands her presence at any endangered shore district, or among the shipping, in either river. Just at present her responsibilities are increased by the W. F. Havemeyer being laid off for repairs, and she responds to all river and shore first alarms. Extended as is that territory, she is swift enough to get over it in very good time. Her ordinary time for getting from her berth to the Battery is but twelve minutes, and with wind and tide favoring she can make it in ten. Once she went from the foot of West Thirteenth Street to the Morrisania steamboat dock, on the upper side of the Harlem River, in fifty-five minutes.

When an alarm calling for action is received aboard, it sounds a big gong in the pump room, and starts an automatic rattling gong in the bunk room, if the men are abed. By the time the captain has told the pilot on duty what dock to make for, the shore lines have been thrown off, the cable disconnected, and the engineer, with his hand on the throttle valve, stands ready to start at the first touch of his bell. While going to the fire, the men get ready all the appliances likely to be required, and take their positions. It might be supposed that service on the fireboat is easier than in a land engine company, but such is not the fact. To keep the boat and all her machinery in the clean and polished condition that is required demands a great deal of labor. Coal has to be got in, and ashes got out, the latter daily.

Then this company has no horse to lay down and take up hose, but has to carry every length of hose to where it may be required, carry it back aboard when the fire is over, and, after cleaning, stretch it on hooks along the rail, or put it on the huge reel that stands on the forward deck. That reel is worth special mention. It stands on a circular track, and though it carries forty lengths of 2½ inch rubber hose, weighing about 3,200 pounds, it can be swung around into position with one hand. Two of the standpipes invented by Chief Hugh Bonner are rigged up, one on the forward main deck, and the other aft on the hurricane deck. In action, a hose is led from the pump to one of these standpipes, and coupled to it. Then one man can hold the stream steadily at any required elevation or direction by simply turning, by a crank, a little cogged cylinder that works in a cogged semicircle under and in line with the standpipe. The invention is highly commended by the crew of the Zophar Mills.

The work of the fireboat is on a large scale. The fires with which she has to contend are generally very dangerous and difficult to manage, being either in big warehouses ashore—sometimes as far away from the river as Greenwich Street—or in the holds of vessels, where they cannot be readily got at. When the latter is the case, it is frequently deemed the safest and best course to literally fill with water the compartment or hold in which the fire is burning. To do this, a six inch hose attached to each pump hurls a cataract of water at every second where it will do the most good. Sometimes when this is not deemed necessary, and still the hold cannot be entered because of smoke, a revolving nozzle is put on the end of a line of 3½ inch hose and thrown over into the hatchway, where it swings, and, spinning around, throws streams in a heavy shower over a circle of some thirty or forty feet in diameter. In other cases a spray nozzle is used, throwing eight small streams together. But in whatever way the water may be applied, one requirement is always the same—that there shall be plenty of it.

The largest land engines possessed by the Fire Department throw only 900 or 1,000 gallons a minute, but the pumps of the Zophar Mills not only deliver nearly three times as much, but the magnitude of their streams increases their efficiency quite out of proportion to the increased volume of water, so that it is estimated that she is as good as ten land engines at a really big fire. She can, as described, pour a six inch torrent from each side if desired, or by "siamesing" the eight lines of hose, for which connections are provided on her pumps, can give sixteen strong streams for simultaneous use. Indeed, her capacity has never been fully tested.

Probably the nearest to a test was afforded in March, 1884, when Fire Commissioner Purroy used her to demonstrate the feasibility of his portable tank scheme for protection of the dry goods district. At that trial the Zophar Mills threw water three-quarters of a mile into the tank faster than four steam fire engines could pump it out. And that she did under disadvantageous conditions. Not having enough six inch hose to lay down all that distance, she had to work through a series of connections that must have greatly impeded her efforts by increasing the friction.

First there were eight 3½ inch lines of hose connected with the pumps and led into one 6 inch hose; then a Y connection carried the stream through two long parallel 3½ inch lines of hose as far as that kind held out; then another Y joined the two streams again in one 4 inch hose, and that was finally reduced into a 3½ inch hose that extended to the tank. And still the four engines, working at their best, could not take all her water. A place is provided aboard for a third pump, and the steam connections are all ready, but it does not seem probable that it will ever be required.

The coal bunkers hold fifteen tons of coal, which lasts five or six days in ordinary service, and the water tanks contain 3,000 gallons of fresh water, for the boilers and other uses. Should she run short of coal, she can receive a supply at almost any dock where she might happen to be when the necessity arose.

The crew of the Zophar Mills have done some life saving as well as fire extinguishing. When the steamboat Riverdale exploded her boilers, on Sept. 8, 1884, the fireboat's crew saved from drowning three persons, two of whom died soon after from nervous shock and scalding. The one who died of nervous shock was Thos. Gregg, a Sir Knight of Morton Commandery, and that Masonic body sent an appreciative and complimentary letter to Captain Farrell and his men. One of the men, Dixon McQueen—a sturdy young fellow who has been about the river all his life—has earned quite a reputation by his skill and courage in saving persons from drowning. He has saved seventeen lives, and has a big silver medal given him by the Life Saving Benevolent Association of New York. He also possesses a silver medal won by him on Sept. 4, 1883, at single-scull rowing.

The fireboat crew say that they have to answer more calls, and do more duty, in the course of a month than any land company. In twenty-nine days of July, this year, they were called ut sixteen times, and that was not an unusually busy month either.—*N. Y. Sun.*

ENGLISH AND AMERICAN LOCOMOTIVES.

MR. O'NEALE'S laugh at me in New York sped its way over the Atlantic, and, reflected from your columns, came back to me after a 6,000 miles journey fresh, sparkling, and racy, as it left him; and as I read it I think I see pleasant smiles lighting up many faces, my inaccuracies, misstatements, and big adjectives all are ridiculously wrong, and England may lie down happy, feeling that her old steam horse is a far better animal than the American colt.

Now I had been preparing what I had hoped would be my last letter to you on this subject, and was rather in a lugubrious mood when Mr. O'Neale's letter came and dispelled my melancholy, and I said, "Let us laugh together and have a good time in this letter."

I feel greatly flattered at the pointed attention Mr. O'Neale pays me in his letter, indeed I am in all his thoughts; he has a good many doubts and fears about what he sees, but he turns every time to hammer at me; and therefore, greatly against my will, I am compelled to speak about myself. Now I will at once confess that I have been often laughed at by mechanical men.

1. I was laughed at when I took up my old friend Sir Joseph Whitworth's system of fine measurement, and made his ideal a practical reality in locomotive workshop practice, bringing in that precision and certainty of workmanship which now prevails in all first-class workshops of England and America to-day.

2. I was laughed at when on this basis of fine measurement I established a system of duplicating locomotives, by which they could be produced all perfectly alike, any part being interchangeable; this, with the utmost economy, a system which has not been excelled even in America, and which England must yet adopt, if she is to take the lead in the manufacture of locomotives.

3. I often laugh at myself when, with the brightest prospects as a locomotive engineer, I left them and went to Leeds to make duplicate locomotive boilers by hydraulic pressure, and on the same principle of fine measurements. This has been partly accomplished, but not so perfectly as it must yet be done.

4. I was laughed at when some fifteen years ago I brought from America samples of crucible steel plates possessing the properties of copper, and showing they could be softened by quenching them in water when red-hot, and that I had seen them in use for fireboxes in America, and recommended their adoption in England. According to Mr. O'Neale, Canada is in advance of England in this respect, and let me ask what would England have saved in copper fireboxes and brass tubes if she had taken my advice?

Now I am perfectly willing to be laughed at for all these things; some have come out all right, and the others must come, and I am not ashamed of them; but I never thought I could be laughed at for the "theory" "that a chilled wheel would outlast a steel-tired one." I ran, I believe, the first steel tires Krupp sent to England; as a steel manufacturer, I have made hundreds of steel tires.

I visited America fifteen years ago, and saw all the principal railways and shops. Then, in 1876, I went through the best New England workshops, and spent some months studying the finest show of machinery this world has ever seen at the Centennial. Since 1881 I have resided here, where I see, most days, some railway practice. I have traveled largely over this country, from Montreal to Florida, and westward across Kansas, and now, with all this experience and knowledge, an associate member of the Institute of Civil Engineers fastens on me a theory of the most ridiculous and absurd kind, comes to America to find it proved, shows how ridiculously wrong I am, and sets the world laughing at me! Surely I may, in turn, laugh at the man who invented such a theory.

Mr. O'Neale seems to have met with some blundering workmanship in his travels, and he says against the bar frame that there are fifty welds in each, that they are difficult to make and occasionally give way. Now granted all this, are all welded-up frames for heavy machinery to be given up?—stern frames for screw steamers, etc. Mr. O'Neale's argument is really against all welding, and not against the bar frame, and his deductions are original and droll.

"A wheel will run with several bad welds, but a frame will not, and this is the greatest defect of the bar frame."

Now my argument against the English wheel, as compared with the American, was that the material of which it was made, and the principles on which it was constructed, were wrong, and every weld in it unnecessary. Yet Mr. O'Neale justifies the welds in the wheel, and condemns them in the frame, and counts them up against it. Let us count up the welds in an English and American train of fifty wagons:

English Train:				Welds.
Engine	6 wheels, say	50 welds each	.....	300
Tender	6 " "	50 "	.....	300
Wagons 200	" "	30 "	.....	6,000
		Total welds		6,609
American Train.....		.....		100

Now carry this out in all the railway stock in England to-day and you will find 66 million more welds than in the same quantity of American wheels; or suppose America had adopted the English wheel, there would have been 200 million more welds in its stock than there are to-day. And looking at the matter not only as it stands to-day, but going back over the early period of railways, from then till now, I ask Mr. O'Neale if there is any adjective strong enough to commend the economy, simplicity, and science which led the Americans to retain and improve the cast iron chilled wheel.

On American railroads to-day there must be running nearly 7,000,000 of wheels; of these 143,000 are under passenger cars, of which a very small number have steel tires, many I believe on paper centers, but the number of them is small, though increasing. The great wheel of America is the cast iron wheel with the chilled face for carriage and wagon stock; and for engines the cast iron wheel with steel tires, and with no complicated fastenings of any kind to secure the tire to the wheel. Had Mr. O'Neale had any doubt as to the strength of the chilled wheels, he should have asked the makers he met to test one for him. I have always found them willing to do so, and the wheels very tough subjects to break up.

Mr. O'Neale accuses me of making misrepresentations, but I do not charge him with making misrepresentations or trying to mislead your readers by saying that all bar-frames have fifty welds each, or that it was a usual thing for engines new from the manufactory to have their frames rewelded. He and I belong to an honorable profession, are members of an honorable institution, and should not accuse each other lightly of dishonorable things. America is a large country, things move quickly, and one cannot verify all one hears. I beg he will be as lenient to me as I am to him. I may be misled, I am not infallible, but I must inform Mr. O'Neale that if he had made inquiries he would have found plenty of bar frames in which there *were no weldings*, the pedestals or horn plates being secured by bolts and keys. I believe there are far more frames built in this way than with welded frames. Many engineers prefer them because of the facility it gives for repairing them, when they get bent or broken by an accident.

Now perhaps I ought to understand bar-frames better than Mr. O'Neale, because I began my locomotive career at Bury's, in Liverpool, where only the bar-frame was used, and there is very little difference between the American and Bury frame, except in strength of section, for engines with 20 in. cylinders run with this built-up frame. And now having swept away Mr. O'Neale's great objection to the bar-frame by getting rid of the welds, his argument about the plate slotting machines also comes to nothing.

Now I don't want to be hard on Mr. O'Neale, for he has made a very common mistake of English people who come over here for three months, who think they know everything and rush into print. He complains of my inferences; now what inferences could be drawn from his letter?

That it is a ludicrous thing to compare the American engine with the English one.

That bar-frames are difficult to make, and many have to be rewelded after being in use.

That it is dangerous traveling on account of broken wheels.

That English wheels are largely taking the place of American ones in the United States and Canada.

I honestly think Mr. O'Neale is sincere in believing these things, and had no intention of misleading any one, but Mr. O'Neale has not learnt very much, because he has come here with a biased mind; he has studied the bar frame, but how little he knows about it; he has studied the chilled wheel, but he has never tried to break one. He knows nothing about the Wooten engine, does not appear to have seen one. He confesses the steel firebox will last for sixteen years or more, but he throws doubts even on it when there is lime in the water.

He does not say a word about the saving in cost by using the American engine, about the crank-axle being eliminated, steel tires running without fastenings on engine wheels, or how much longer an engine will run without repairs when constructed so simply. He does not see, what most mechanics discern, the mechanical genius of the country, in the system of duplication, which runs through everything. Even when talking on his own subject he is not sure about it, but takes out his drawing, and then says a bar frame requires more slotting than a plate frame.

In concluding this letter, while I have felt compelled to say many things about myself, I must add that I am a loyal British subject, and in writing as I have done I have no other end in view than the good of my country. I believed Mr. Burnett was leading England into a fool's paradise, by praising the English locomotive at the expense of the American one. For the last fifteen years I have studied the progress and advancement of railway invention in this country, and seen England falling behind in the race; and that I might the more vividly impress my belief on English mechanical men, I have spoken of myself and my work.

Few men have had such opportunies of judging and weighing this question, and in ordinary circumstances my opinion, founded on a long knowledge, might be considered as authoritative. Mr. O'Neale might have done much to settle this question had he entered into it with proper spirit. The best he could have done would have been to publish some of the runnings of the engines he saw, and compare them with the mileage made on British railways; and in order to afford an opportunity for your readers to do this, I append the running of the standard engines of the Pennsylvania Railroad, that he may still more despise the system of standards in duplication of engines which I recommended, and which he may laugh at as he laughed at me.

Thirty-ninth report of the Board of Directors of the Pennsylvania Railroad to its stockholders, March 9, 1886, that is for year 1885:

Page 120. Number of locomotives 1,360
Leased 27
Condemned 4 31
Engines 1,229

Page 116. Total mileage 34,025,750
Freight mileage 22,052,186
Passenger mileage 11,973,564

Page 121.

Divisions of Line.	Greatest Mileage of any Engine.	General Average Mileage.	Average on Three Roads.
Passenger Engines.			
Pennsylvania Railroad	80,385	35,475	33,784 miles
New Jersey	61,043	31,182	
Philadelphia and Erie	61,412	40,798	
Freight Engines.			
Pennsylvania Railroad	50,360	26,464	average 25,227 miles
New Jersey	44,839	25,134	
Philadelphia and Erie	36,594	25,284	

The engine which ran 80,385 miles in 1885 must have run 1,545 miles in every week during the year, and 220 miles in every day in the year to make this mileage.

I am, yours faithfully,
JOHN FIRNIE, M. Inst. C. E.
Dundaff, Pa., U. S. A., July 5, 1886.

SIBLEY COLLEGE LECTURES.—XI.

BY THE CORNELL UNIVERSITY NON-RESIDENT LECTURERS IN MECHANICAL ENGINEERING.

THE "LABOR PROBLEM."

WITH A DISCUSSION BY PRESIDENT ADAMS AND OTHERS.

First Session.

INTRODUCTION, BY THE DIRECTOR, DR. R. H. THURSTON.

GENTLEMEN: It has been the intention, in the organization of this course of lectures which has been carried on through the past year, not simply to bring before you gentlemen distinguished in the profession, who may give you information, and communicate to you knowledge of professional matters in which each has become famous as a specialist, as an expert, but, quite as much, to present to you the thoughts of these advanced thinkers of your profession, with the purpose of awakening your own thoughts to the great events and the great advances of the time. It has been fully as much for the purpose of setting you to thinking on these great subjects as to give you instruction, that you have been brought to meet these lecturers, at your weekly conventions. It is especially with the hope of accomplishing this awakening of the members of the undergraduate associations of engineers and architects to an appreciation of the nature and importance of the great questions of the day that you are invited to listen, to-day, to a discussion of the most absorbing of all the questions of the time, to give your own minds to the study of the problem, and to a comparison of the views—which you may expect to find somewhat diverse—of those who enter into the debate.

It is now just about a century since James Watt began his wonderful career, as the inventor of the modern steam-engine; and in the hundred years which have passed since then, we have seen the fruit of the seed planted by him, in the development of a thousand arts till then unknown, or, if known, feebly struggling for life. The introduction of the steam engine, in the freeing of mines from water, in the impulsion of all kinds of mill machinery, in the transportation of all products and the materials of all industries, has given an impetus to manufactures, and has so enormously accelerated the advance of civilization in all industrial directions, that all the conditions of life have been modified, and, in the vast majority of cases, completely revolutionized. But such tremendous social changes as have followed the operation of that remarkable train of circumstances due to the action of the genius of the great engineer, which have now been influencing the world for so long a time, could not be expected to take place without the production of more or less, perhaps in many directions very serious, embarrassments and of some actual suffering; and, although the gain may be out of all proportion to the loss, and although the suffering may be, and undoubtedly is, small in proportion to the reduction of the inconveniences of the whole people and to the gain of the race in all the necessities, comforts, and luxuries of life, it is none the less our duty to study the causes of this ill effect of the growth of this great good to the world, and it is our privilege, each in his way, to do what can be done to reduce the evil to its least possible dimensions.

The immediate consequences of the introduction of the steam engine, and of the other great mechanical inventions which have followed in its train, and which have largely been made possible by the application of steam to the production of useful, unlimited, and cheap power, have been a most wonderful, an inconceivably great, increase of the power of the world to produce every article of food, of clothing, of whatever is needed or desired by the race. So enormously have our powers of production been increased, that one man can to-day, in many departments, do more than could a regiment a century ago; the poorest can procure articles of food, kinds of clothing, house furnishings, comforts, luxuries even, such as kings could not command before the birth of James Watt, of Arkwright, of Hargreaves, of Stephenson. So great is this increase in the power of production, that it is now easy for the civilized working world to produce more than the civilized world can use or buy. Not only this, but the producing power of the world is continually increasing, though irregularly, in a saltatory manner, in all directions. It is thus continually happening that some one or more among our great industries is every now and then made capable of doing more than is necessary to supply the market; and the stock of manufactured articles produced by it imperceptibly increasing, it finally becomes discovered that the market is overstocked, and production is suddenly checked, or perhaps ceases, until the surplus is worked off upon a suddenly straitened people. These "crises" occur more frequently, and are the more serious, as the progress of invention and the accumulation of capital is accelerated. Industries grow, also, unsymmetrically, and at various rates, compelling readjustments of the amounts of labor and of capital turned into their several channels. It is in consequence—largely, certainly, if not mainly—of these unfortunate results of the good fortune of a world blessed by inventors and engineers, that we have constantly to witness much of embarrassment and suffering on the part of honest, industrious, conscientious workingmen and small proprietors. The "labor problem" very possibly finds its origin principally in this good fortune. It is this problem that we are led to examine through the minds of the speakers who are to honor and instruct us by their participation in the discussion about to be entered upon.

There is to-day no subject of greater interest to the public than the so-called "Labor Problem;" and the engineer is, naturally, in consequence of his intimate relations with the people and the subject, vastly more interested than can be the average citizen. It is the engineer, or the closely related worker with the engineer, who directs the great mass of labor in this country. The civil engineer directs all construction on our railroads and canals, on our water works and public works of whatever kind; it is the mechanical engineer who directs labor in all branches of manufactures, and in the management of all the machinery of this machine-employing age; it is the architect who, however indirectly, controls the labor of the building trades. All these working people, who constitute so large a proportion of the workingmen of the country, are so closely related to us and to our work that we cannot but take a livelier interest in this subject than can possibly any other class of professional men. It is, in fact, our colleagues, it is you who are about going out into the working world, who are to manage the great world of labor; and it is of you, very possibly, that the solution of this great problem will be demanded. It is, indeed, to you a "burning question."

This matter to-day assumes extraordinary importance, and this discussion will be followed with the greater interest, because of the fact that we are in the very midst of one of those great upheavals and agitations which mark the progress of a social revolution which is undoubtedly in operation. It is a revolution which we may hope and expect to be, in the main, a bloodless one, but it is revolution, nevertheless; and we may confidently hope that it will prove to be, like all great revolutions, productive of salutary changes, and of good to all classes. We may be sure that the right will prevail, and that the only questions which will have serious consideration by the people—and it is the people who will settle all such questions, in the end—will be those which concern the nature and extent of the rights of each citizen, whether he be capitalist or laborer, employer or employe. These questions will be studied, and a righteous descision will, in good time, be rendered.

It gives me great pleasure to be able to introduce to you Professor Henry C. Adams, who will open this discussion of the "Labor Problem."

Prof. H. C. ADAMS:

GENTLEMEN: In speaking to you this afternoon upon the Labor Movement, the greatest and indeed the characteristic movement of the present century, I would disclaim at the beginning any intention of presenting a complete statement, much less a complete solution, of the problem involved. Such a task is too great to be undertaken in the course of a single address. This labor problem touches social and political questions at every point, while a full appreciation of its claims demands an extensive acquaintance with historical facts and philosophical controversies. Should we consider it historically, our study would lead us back to the time when individualism first became a potent factor in political society, and when competitive action first began to make itself felt in industrial affairs. Or should we view the matter from the standpoint of philosophy, our analysis would carry us to a consideration of the most profound truths respecting personal rights and to the most abstruse questions concerning the nature and basis of private property. So broad and so deep is this sea of controversy called the labor question, so strong are the currents of counter sentiments and counter interests by which it is moved, and so violent are the winds of passion and of ignorance sweeping its surface, that it would be presumption on the part of any man to say with too much certainty how society will eventually succeed in crossing it. The most that one can undertake is to display as it were a chart of this troublesome sea, and mark upon it the route by which he believes the ship bearing the freightage of our civilization may pass from its present moorings to the harbor of plenty with peace. Such is my purpose this afternoon; and though in the course of my remarks I may venture statements without attempt at proof, I trust the impression will not be left upon your minds that they are statements incapable of proof.

Speaking, then, my own views upon this subject, I would say, the first step in the solution of the labor question is to recognize that it exists as a great social problem, for not till then may we expect it to receive the best thought of the best minds. But even this first step has not been generally taken. There are many who deny that workmen have a just complaint against the existing organization of industrial society, and several books have recently made their appearance endeavoring to prove that the labor agitation has no basis in reason. Such a book is "The Distribution of Product," from the pen of Mr. Edward Atkinson. Its purpose is to prove from the records of cotton mills the assumption of Bastiat, that "in proportion to the increase of capital, the absolute share of the total product falling to the capitalists is augmented, while, on the contrary, the share of the laborer is increased both absolutely and relatively." Admitting for the moment this statement as true, there would yet remain a social problem; for the tendency of machine industry, under the direction of unrestrained competition, is to decrease relatively the numbers that find their way into the capitalist class. This means the concentration of irresponsible power and the establishment of distinctly marked class relations, both of which tendencies are out of harmony with the aim and end of a democratic society. But the statement itself is not true.

While the efficiency of labor has increased five hundred per cent., the rate of wages has increased but one hundred per cent. The secret of modern riches is that men have ceased to use tools, and have begun to use machines. A tool is an implement by which man employs to better advantage his own powers; a machine is a mechanism by means of which he brings under his control the forces of nature. But nature works without pay; man therefore is doubly paid. It is because nature works gratuitously with man that the efficiency of his labor has increased fivefold; and it is because average comforts and the possibilities of life for the average man have not increased fivefold since the introduction of machinery, that one need not hesitate to declare the existence of a great social problem. To deny it in the face of these facts would be to confess moral incapacity.

The political economist who does not disdain history, and who is willing to laboriously trace the development of industrial society through the last five centuries of its growth (rather than rest content with recording movements of the last five decades of the present century), must rise from his investigation with at least the suspicion fastened upon him that Rodbertus was right when he said: "Present social arrangements for the production and distribution of wealth result in giving to the workers, in the shape of wages, a smaller and smaller proportional share of the wealth created by improved methods of production." I cannot of course stop to argue this claim, but I believe it to be substantially correct. In this case the French author is wrong, and the German right. The principle of competition applied to the distribution of what is produced under the regime of great industries, while capital, held and controlled as private property, is concentrated in the hands of a comparatively few, and while laborers are unorganized and isolated, will give to the employer such an advantage as to exclude the laborer from a just share in the benefits of an advancing material civilization. And admitting this to be true, there certainly is found in this fact a rational basis for the complaint of laborers. There is a meaning of prevalent agitation which we cannot ignore. Viewed from whatever point we choose, this movement is nothing less than a social movement, and, being a social movement, it presents a problem the solution of which will constitute a social revolution.

And what is a social revolution? This phrase should not startle us, for the movement which it describes need not come with violence and disaster, but may proceed as though part of the natural growth of society. A social revolution consists in some change in the efficient ideas that control the actions and decisions of men. If this change be of such a nature as to touch the political structure of society or the established rules of property, it will be reflected in those fundamental laws of the country which guard the rights and privileges of men. Or, if it be a change that refers to social or industrial relations, it may extend no farther than to influence the prevalent customs of society; but in either case the revolution consists in some modification of the manner in which men regard certain affairs.

A proper conception of the essential character of a social movement is so important that I venture to illustrate from a well-known fact of English history. There was a time in England when public sentiment accepted without very much question the thought that the king ruled by virtue of some right God-given or within himself. This view of governmental authority came finally to be known as the doctrine of the divine right of kings. But when the rulers, gathering the robe of their divinity about them, pressed their prerogatives so far as to encroach upon certain rights which the people believed to have been reserved to themselves, there sprang up, as opposed to this doctrine of the divine right of kings, another doctrine, which taught that kings ruled by sufferance of the people. The idea of irresponsible power was confronted by that of strict accountability in the exercise of public authority. Between such views there was no hope of compromise, and it was only after a severe and protracted struggle that the idea of the right of self government was enthroned in the minds of men. The battles upon which historians dwell with such interest are of slight importance; the revolution by which political liberty was secured was nothing more—and nothing less—than a change in the manner in which the average Englishman viewed questions of government.

But though a social revolution is in form so simple a

thing, the popular agitation that leads to its accomplishment is not born of leadership. There are not a few who assume to think that all our labor difficulties are due to agitators and demagogues, who arouse to discontent and excite to resistance for no other purpose than to satisfy their own love of power. There can be no greater delusion. Such an intrepretation of prevalent discontent rests upon a thorough distrust of human nature, which the fair success of our hundred years of self-government does not permit a wise and candid man to entertain. It is possible that a riot, or, indeed, an uprising on a small scale, may be the result of an eloquent appeal. There is no idea so crazy that it will not find a few adherents when propounded to millions of men. But where there is observed an almost unanimous movement on the part of any class of men, based upon a sense of wrong among those men, it is either the absurdity of prejudice or the cunning of personal interests which leads one to say that such a movement is the result of the eloquence of ignorant and demagogical leaders. I do not think I am going beyond the warrant of historical teaching when I say that a widespread discontent proves the existence of a just cause of complaint; and the existence of a cause of complaint that touches the lives of a large body of men is sure to find expression sooner or later, by the lips of a so-called leader. A social movement is greater than any man; it makes the man, the man does not make it.

But if it be true that the world is even now passing through a change of thought which, when realized in the habits of the people, will be called a revolution, it is wise to inquire respecting the nature of such a change. What is the aim and end of this movement which is to give color to the history of the last quarter of nineteenth century?

There are many ways in which this question may be answered. Viewed historically, the labor movement of the present day must be considered as a step in the further development of individual rights. It may occur to some that this is an unfortunate time to speak of the development of individual rights, when labor organizations are adopting measures and following methods not in harmony with established views of personal liberty; but if one has confidence in his own views, he will neither suppress nor modify them because of the exaggerated claims of those who happen to be in the position of leaders of the workingmen. I do not wish, then, to modify my statement that the labor agitation is a natural and a necessary step in the further development of modern history.

Modern history, introduced upon the fall of feudalism, has witnessed two radical changes in the customary thoughts of men. Thus the great religious revolution called the Reformation secured for each man the right to maintain his own opinions in matters spiritual—a right that has naturally grown into the modern doctrine of freedom of thought, freedom of speech, and freedom of the press. The political revolution, on the other hand, realized through the struggle for ministerial responsibility, secured for men the right of self-government. But there is a third domain of activity which, together with the religious and the political, makes up the trilogy of interests that constitutes society, but in which no corresponding rights have as yet been developed. I refer to industrial activity; and, if my interpretation of the modern labor controversy be correct, we cannot hope for quiet and peace until the industrial organization is brought under the guidance of the same principle of control to which the religious and political interests of men have already been subjected. This will constitute the industrial revolution necessary to restore harmony to the social order, and that necessary, as a last step, in the realization of the purpose of modern history.

A statement of this sort may be easily misapprehended. It will be asked: Did not the rise of free labor, consequent upon the fall of feudalism and the guilds, secure for men, as members of industrial society, all rights and all freedom now enjoyed by them as members of political society? That the right of personal freedom was necessary as preparing the way for the social movements of the last three centuries, none will care to deny; but that the liberties of men should be judged by the wording of the law, rather than by the actual condition in which men find themselves for maintaining their independence, is open to reasonable doubt. This question, if intended as a criticism upon my statement of the labor problem, indicates a failure to appreciate the fundamental idea upon which Anglo-Saxon institutions rest. The purpose of both English and American law is to attach a duty to every right. It recognizes no liberty except as held to strict account. Nothing, indeed, can be so foreign to the spirit of our institutions as the granting of any privilege, whether political or proprietary, freed from the restraints of responsibility. This becomes at once clear when we consider the nature of political liberty with which we are familiar. When men acquired the right of self-government, they did not for a moment entertain the thought of abolishing government; their full purpose was realized in doing away with the exercise of irresponsible power by the representatives of government. That is to say, where men are politically free, the king governs; he no longer rules; ministers are public servants, and not public masters.

Carrying this truth respecting the political revolution over into industrial affairs, we may perhaps see, by a little energetic use of the imagination, what changes are demanded in industrial relations, in order that they may be brought into harmony with the idea of equal rights realized in our political institutions. The great power of the nineteenth century is capital. He who controls capital controls men. But, according to existing law, capital is held as the personal property of him who accumulates it, and its use is in consequence imposed with few restrictions. There is not time to discuss before you the question as to whether this accumulated power called capital is or is not a social product; but, assuming my own views upon the subject to be correct, and answering the question in the affirmative, it follows that the use of this social product should be granted to individuals only on conditions of strict responsibility to society. There is no more reason for granting irresponsible control over this, the greatest social force of the day, than for permitting irresponsible control over the exercise of the coercive powers of government.

We come, then, to this conclusion: The guiding purpose of the industrial revolution through which we must pass is the same as that of the political revolution through which we have passed. The change demanded consists in this: that the exercise of industrial power, like the exercise of political power, should be held to strict account.

But why, it may be asked, was it reserved for the latter part of the nineteenth century to take this last step in the development of the idea of modern history? Why did not our forefathers, the fruit of whose courage and wisdom we now enjoy in the rights of political freedom, impose, at the same time, adequate responsibility upon those who exercised industrial power? The answer to this question is simple, though few seem able to perceive its importance. When political liberty was secured by the establishment of a responsible ministry, there did not exist industrial power of the sort which now forms the basis of modern civilization. We cannot overestimate the social importance of inventions. They have created for us a new world; and, unless one is capable of recognizing this, he may as well abandon the hope of understanding the labor question of to-day. While industries were numerous and small, while workmen were themselves owners of the places in which they worked, of the tools with which they worked, and of the materials upon which they worked, and at the same time had access to a comparatively steady market for the sale of product, the ordinary rights of personal freedom were ample to secure to men the enjoyment of the fruits of their labor. But now, under the regime of great industries, when the laborer is proprietor of nothing but himself, and is dependent upon the owner of machines, of material, and of place for the opportunity to work, and where the market, though broadened and extended, presents an unsteadiness that the old society never knew, it is folly to say that the same law of liberty will produce parallel results. The truth is that the theory of liberty upon which the French revolution was fought to a successful issue, which placed the personal right to acquire property on the same footing as the right to security of life, is no longer applicable to modern society. It does not fit into the regime of great industries. Men knew the evils of concentrated irresponsible political power, but of the pernicious results of the concentration of power that comes with the accumulation of capital they were wholly ignorant. And this is the reason why it was reserved for the present generation, impelled by the same hope of personal freedom and by the same appreciation of social fairness and social equality that inspired the leaders of the English and the French revolution, to impose such conditions upon the exercise of industrial power that the material progress of our century may become the source of highest blessings to all.

I have endeavored, in this hasty manner, to suggest the permanent trend of modern history, and to show you that this labor movement, touching so closely our own lives, is but a further development of the fixed purpose of liberty-loving men of the past. It is possible that some of you may agree with my presentation, or at least be pleased to learn that there may be a solution of present difficulties involving neither the tyranny of socialism nor the creation in this country of a Prussian police. As yet you withhold assent because of the excesses committed by some of the labor organizations in the course of their agitation. I will not attempt an apology for all that workingmen have done in their endeavor to advance their own interests. Such a task would be impossible of accomplishment. But if we brush away the froth of this agitation, and look into the real purpose that lies beneath, we shall find, I think, that the more intelligent of laborers are advancing claims quite in harmony with the views I have expressed. For testing the truth of this conclusion, we must consider the claims which workingmen present.*

It has been my custom, for some time past, to collate the causes for which strikes have been set on foot, as well as the manner in which they have been settled; and, as the result of this, one fact at least has been presented clearly to my mind. The labor agitation in this country is now beginning to take upon itself a new meaning, because the labor organizations have set before themselves a new purpose. The right of combination is no longer denied. There is no danger at present that leaders of trades-unions will be prosecuted under "conspiracy acts," unless they urge violence.

It is well recognized that the methods of modern industries compel the concentration of capital, and that men who are without property in tools or shop must unite, or they will surely get the worst of any bargain. Individualism for them is social suicide. This was the state of affairs before the present movement toward the federation of the various trades into a great labor organization. But it is not necessary, for my present purpose, to show how unions of trades came to take the place of unions of men in trades; for it is the use that is being made of organization, rather than the nature of organization, which is of importance.

Until within a few years, the questions which the "unions" endeavored to settle were questions of wages, of hours of labor, and of apprentice regulations. But the sad experience of struggling after immediate results, while permitting the future to take care of itself, seems to have suggested a new idea. It is now seen that there is something more in the labor controversy than questions of wages, hours, and apprentice regulations.

In the settlement of actual difficulties, the thought naturally suggested itself that some provision ought to be made for the settlement of future difficulties without the loss necessarily attendant upon protracted struggles. This was the first step in a new departure. It led necessarily to a demand that boards of arbitration be established to which all questions should be referred for settlement. It is not too much to say that at the present time the workmen of the United States stand committed to arbitration. The Knights of Labor place it as an important plank in their platform, and more than one paper devoted to the interests of the wage-earner adopts it as an appropriate motto.

But other claims have been added to the demand for arbitration. The most important of these is what may be termed a demand for tenure of employment during good behavior; and it requires but a slight analysis of this to see that the end which the workmen have in view is to establish for themselves a right of implied partnership.

It makes but little difference what strikes we consider for testing this conclusion; the "diplomatic notes" that pass between the contending parties will show the real point at issue to be one of organization.

I am willing to consider even the late strike on the Gould system of railroads, notwithstanding the fact that public sentiment, in this case, has gone against the workingmen; nor will it weaken my position in the least to admit that this strike was unwarranted, and its leaders deficient in the qualities of leadership. The true meaning of any controversy is disclosed by the claims that underlie it, and not by the manner in which it is conducted. In the present instance, the demands of the workmen were as follows:

1. That there be no reduction in the rate of wages of any employe on the road, unless it be decided by an arbitration committee, the railroad company to appoint three and the Knights of Labor three.

. . . . . .

3. That no employe be discharged without a just cause, said employe having the right to ask for an investigation if he thinks he was unjustly discharged.

4. That all promotions, such as foremen, be made from the ranks.

. . . . . .

6. If it become necessary to reduce expenses, the men should be consulted as to whether it shall be a reduction of hours or a reduction of men.

7. That should any matter come up between the employes and the company, it shall be decided by an arbitrating committee of six, three from the company and three from the Knights of Labor; and the company and the Knights of Labor agree to abide by their decision.

Is it not clear, from reading these claims, that the workingmen are endeavoring to create for themselves, upon the basis of an agreement, certain rights not recognized in the present organization of industries? The editor of the *Globe-Democrat* of St. Louis sees this in part, but does not understand it; for in speaking of the matter he says:

"There has not been a single point in the contest thus far at which a legitimate issue between capital and labor could have been presented for arbitration. The strike is based upon a demand totally unknown to the history of arbitration, and totally impossible as a thing to arbitrate."

Of course it would be a little difficult to present the question of the right to arbitrate before a board of arbitration, but it is rather hard to imply that this is not a "legitimate issue between capital and labor." The truth is that this is the only legitimate issue between capital and labor; and if this issue can be settled in favor of arbitration, the rest will take care of itself. This is true because arbitration is the machinery by means of which responsibilities may be imposed upon the legal proprietors of the world's capital; it is the means by which a fair share in the benefits of industrial advancement may be secured to those who possess no productive property.

Ex-Governor Brown, on the other hand, whose duty it was to reply to these demands, seems to grasp the true meaning of the situation. A recognition of such claims, he says, would "deprive the receivers of the right to control and operate the property (intrusted to them) under well defined rules of law and common sense." I have nothing to say of the peculiar duties imposed upon a man because he is receiver of a bankrupt concern; but the point at issue here brought before us is one of general interest. The reply of ex-Governor Brown is what any manager of any industry would be likely to say, if called upon to make a partial surrender of his control over what he terms his private property.

On the other hand, what the Knights of Labor say is, that they desire to exercise some of the rights of proprietorship over the industry to which they give their skill and their time. And it is certainly true that concession to their demands would deprive men now controlling industries of the right to control and operate their property "under well defined rules of law;" but we will not add "and common sense," for that is the question at issue.

We need not follow at greater length the specific claims of the laborers as displayed in this controversy, for enough has been said to show that the question of wages was subordinated to the question of internal organization. In this fact, which so surprised the public, lies the significance of the latest phase of the labor controversy. What the workmen demand is such an organization of the industries to which they give their time that certain rights shall be granted to them, even though they are not proprietors, in the ordinary acceptance of that word. In some instances, such rights have been secured. The lock-out on the elevated railroads a few months ago resulted in the concession that no engineer should be discharged from the employment of the company without just cause. In a small factory in Connecticut, the settlement of a difficulty resulted in an agreement that wages should fluctuate with profits. This necessarily means a permanent board of arbitration within the concern, before which the books of the company may be scrutinized. Such decisions as these are in perfect harmony with the views expressed in the first part of my address. They admit the claim that capital can no longer be regarded as bearing purely a private character, and that proprietorship in productive agencies can be admitted only on condition of strict responsibility. Such decisions as these may be regarded as prophecies of a new industrial organization.

May it not, then, be said that the workingmen of the United States have at last gotten hold of the right end of the labor problem?

It has for a long time been felt that the principle underlying the theory of co-operation is the one which must eventually solve the labor difficulty. This principle is that proprietorship should be widely extended, in order that the benefits of property may be widely diffused. This is a pretty theory, but the practical question is, How can a man with a wife and six children

* The substance of the remainder of this address has already appeared in print as one of a series of articles on "National Problems," furnished by a syndicate of writers organized by Mr. R. L. Bridgman, of Boston. It may not be inappropriate to say that this syndicate embraces some of the leading writers of the country, as Mr. Carrol D. Wright, General Carrington, Dr. R. T. Ely, Prof. F. W. Taussig, and others.—ED.

save enough out of two dollars a day to buy stock in the Gould system of railroads? There are at present insurmountable obstacles in the way of an extended application of the principle of co-operation. But shall the purpose which underlies the thought be abandoned? May not the benefits of proprietorship be diffused, while the nominal or legal residence of property remains where it now is? If men are given tenure of employment, and cannot be discharged except for cause that satisfies a commission of arbitrators, they may be said to be in the enjoyment of an industrial home; if men are promoted from the ranks (that is, according to civil service rules), they may be said to have a vested interest in the industry; if employes are consulted whether hours of work or the numbers employed shall be reduced, they have secured a right to live in hard times from the fund of capital created by them in flush times; and if all these claims—as well as others naturally implied by them—should be so well established that infringement on either side may be taken into the courts, the practical meaning of proprietorship in productive agencies will be radically changed from that which either custom or law now recognizes. It will be virtually a new law of productive property. It will result in the establishment of an Industrial Federation.

I do not know that the Knights of Labor clearly perceive the full pertinence of their own claims. They are dealing with practical measures, and it may be that, in the heat of the controversy, they fail to recognize the remote consequences of their own acts. Great social movements are seldom thought out by those who are prominent actors. But of one thing we may rest assured: their purpose stands opposed to the tyranny of German socialists on the one hand and to the yet greater tyranny of anarchy on the other; but it is in full harmony with the further development of Anglo-Saxon liberty. Its realization will arrest the disintegrating tendencies of the present, and lead, if we are wise in its direction, to the re-establishment of a society of mutual dependencies. The solution of the labor problem lies in the further development of property rights.

Professor THURSTON: I have now the pleasure of presenting a gentleman who needs no introduction—President Adams.

President CHARLES KENDAL ADAMS, continuing the discussion, disclaimed any intention of presenting a very definite statement of his views on the subject of the debate, or of occupying much time, but would merely offer a few suggestions, and some queries, which had come to his mind as he listened to the interesting remarks of the first speaker, regarding this very important and somewhat abstruse though widely discussed problem.

He was greatly pleased by the thorough and earnest manner in which Professor Adams had attacked the subject. While agreeing with him in much that he had said, it might be allowable to suggest some doubts that had arisen in his own mind on a few points brought up by the speaker in the course of his address. President Adams went on to say that he was not at all convinced that the disturbances now observable, abroad as well as in this country, are such as may be called revolutionary, either in fact or in tendency. They partly arise from the old familiar weakness of human nature which inclines every man to get all that he can, even without rendering a fair equivalent, and from the inclination to demand large pay for little work—an inclination to evade the laws of nature and of business. He could not see that there is any ground for a claim on the part of either side in any bargain that, after a bargain is made, it may be broken by either, and arbitration resorted to to settle differences so arising. If he should agree to employ his coachman at two dollars a day, and if the man were not satisfied, he could, at the proper time, seek other employment; but he would have no claim for more pay, or, claiming a higher wage, could have no right to demand that his claim be submitted to "arbitration." There seemed no place for arbitration in ordinary business affairs of this sort. It seems probable that the existing methods of doing business will continue to be practiced in the future, very much as in the past, and that men will rise or fall in the social scale under the action of familiar laws

[The remarks of President Adams were not fully reported; and we hope to be able to present, later, a satisfactory report of them written out by the speaker himself.—ED.]

Professor THURSTON: We have present with us, to-day, a gentleman who has made the study of these social and economical questions a part of his life's work, and who is well known, throughout the country, as one of the earliest and most able and active among those who, years ago, attacked the greatest evils of our political system, and who is to-day distinguished for his earnestness in the study of the evils attending our usual methods of caring for criminals. He is no less interested in the welfare of honest men who are working and waiting, hoping for better times to come when the final settlement of the "labor question" shall have brought about more prosperous days for themselves and their families. It gives me very great pleasure to be permitted to introduce Mr. Frank B. Sanborn, of Concord, Massachusetts.

Mr. SANBORN said he must agree with President Adams that the present labor movement was not, as Prof. Adams had stated, a further extension of the movement for personal freedom, which had been going on so long, and of which our democratic self-government in America is one result. Practically, the effect of strikes and boycotts was to limit personal freedom, rather than to extend it, while on the other hand the unlimited freedom of men like Jay Gould to acquire enormous fortunes, and to control the fortunes of others, was also a restriction on the freedom of men. Yet so great is the conservative force of property once acquired, that, in this controversy at St. Louis, Jay Gould had shown himself a trustee for others more than acquisitive for himself, and seemed to be more in the right than the strikers. There should be a power in the state to check the excesses whether of organized capital or of organized labor; since each had a tendency to be unjust to the other, although the interests of both were, in fact, identical. Skilled labor could always be trusted to maintain that subordination and wise direction which all organizations of men need, for nobody knew better than the skilled laborer how necessary intelligence and fidelity are, and how impossible it is for ignorance to guide knowledge. The present controversy suggested a story which might illustrate the confusion existing on both sides in regard to the best interests of labor. An Irish carrier was jogging along on horseback, when he found himself suddenly at a standstill; looking round, he saw that his horse had caught one hindfoot in the stirrup. "Begorra!" said Pat to the horse, "if ye're goin' to get on, I'll get off," and he did so.

Professor THURSTON: I am pleased to see that we have with us, to-day, a distinguished member of the Faculty of Cornell, whose interest in all live questions certainly includes peculiar interest in the great problem now under discussion. We may be sure, too, that he has given some thought to the matter already, and that his exact methods of study and of logic must have given rise to some interesting and reliable conclusions. This may not be the field in which a mathematician would find much work; but the man who can make himself a great mathematician is certainly competent to give us thoughts which are at once instructive and eminently suggestive. I will ask Professor Oliver to give us the results of his study of the "Labor Problem."

Professor J. E. OLIVER, of Cornell University:

GENTLEMEN: We who are here belong to the fortunate class. We may not have wealth, but we have some useful training or some heritage of useful gifts, and with reasonable effort we can always secure so much of continued growth and satisfaction as we need and are fit for. Hence it would be ungenerous in us to be too conservative or indifferent as to any system under which we prosper while others, as deserving, do not. If observation, or a philosophical analysis of statistics, shall convince us that any large number of well meaning people about us, whether by nature strong or weak, shrewd or simple, are shut out by poverty, over-work, or other hard conditions from their share of such important benefits of our common civilization as they are fitted to receive, so that their lives are needlessly dry and hopeless, then these people have a right to look to us for aid both in solving the problem thus presented and in bringing about a true reform; and our duty in the matter is hardly affected by the fact that they enjoy a nominal freedom.

The primary problem is one of ends, not of means. First, "What is the true social ideal?" and afterward, "What customs, education, laws, would conduce to it?" Now, two features of the social ideal would seem already clear. First, the tools should remain in the hands that best can use them. Secondly, so much of reward and benefit, so much of security, wealth, leisure, honor, and opportunity, should go to every faithful worker, whether man or woman, as to put within his reach something like the highest development and happiness for which his nature fits him; and this, except in rare cases, not as "charity," but through the normal relations of industrial and social life. But how to reconcile these two features with each other and with individual liberty, in ways that laziness cannot utilize and selfishness cannot evade—this is the problem for us, as good citizens, to work out. Some solution exists; and, little by little, it will be adopted.

(To be continued.)

VEGETABLE OILS AS LUBRICANTS.

By C. G. WARNFORD LOCK.

THE aim of every lubricant is to reduce the friction or grinding action which accompanies the movement of two surfaces in contact with each other. Lubrication consists in interposing between such surfaces some substance or compound of a highly slippery nature, that is to say, offering very little resistance to a moving body. Vegetable oils form one class of substances possessing the necessary qualities; but it must not be supposed that all vegetable oils are alike in this respect, some being totally unsuited The chief properties looked for in a lubricating oil may be classed under the following heads:

PROPERTIES.

1. Freedom from foreign matters.
2. "Body" enough to keep the moving surfaces from coming into actual contact, the lubricant forming a sort of cushion or pad between them.
3. As great "fluidity" as can be attained without sacrificing the body.
4. The lowest possible "coefficient of friction," that is to say, the least tendency to hinder the free movement of the surfaces which it separates.
5. The greatest power of absorbing the heat generated by friction, and distributing it.
6. Absence of any inclination to assume a "gummy" or tenacious condition consequent on oxidizing influence of the surrounding air.
7. Freedom from acid reaction, whether due to (*a*) the presence of manufactured acids applied on a previous occasion for refining purposes, and not completely removed; or (*b*) the formation of natural "fatty acids" by the action of ferments in the oil itself.
8. Requiring a high temperature to bring about vaporization and decomposition, by which the oil is entirely removed, or essentially changed.
9. Requiring a low temperature to induce solidification or "setting."
10. Special conditions according to the case.

The degree in which these properties are present may be estimated the following methods:

HOW DETERMINED.

1. By complete analysis, not within the capability of an ordinary manufacturer, but demanding special training; described at length in Carpenter's "Soap."
2. The density of an oil cannot be estimated by a hydrometer, but must be taken by a "Sprengel's specific gravity tube," or by a special kind of specific gravity bottle, as described in Carpenter's "Soap," p. 93.

3, 4, 5, 6. These are more or less interdependent properties, and may be dealt with in one examination. (*a.*) A usual method is to calculate the rate of flow through a known aperture, for instance, in a Mohr's burette, surrounded by water, kept at a fixed temperature. (*b.*) Noting the time required by a drop to traverse a known distance on an inclined plane surface. (*c.*) Dipping blotting paper in the oil, and holding it up to drain: symmetrical drops show good fluidity; spreading indicates viscosity. (*d.*) Exposing definite quantities in a shallow capsule for twelve hours to a temperature of 266° F. (130° C.), in comparison with a sample of known quality. (*e.*) Spreading a definite quantity on cotton waste, kept at 176° F. (80° C.), and noting when spontaneous combustion takes place.

7. Requires some special knowledge. This process is described in Carpenter's "Soap," p. 86; also very fully by Archbutt, in vol. ix. of the *Analyst*.

8. These conditions refer more especially to mineral oils; vegetable oils, suitable in other respects, are not likely to be impaired to any extent by these features.

9. Easily ascertained by exposing in glass tubes to progressively low temperatures, obtained by employing the various "freezing mixtures" described in Bayley's "Chemists' Pocket Book," pp. 47-48, and more fully in Spon's "Workshop Receipts," iv., 71. Turgidity is the first indication of loss of limpidity.

10. Generally require actual trial. An excellent lubricant for slow, heavy work would not be adapted to high speed, light work, and *vice versa*.

Several statements have been put forward at different times relating to the corrosive action exerted by some oils on copper and iron surfaces. The following table shows the amounts of metal dissolved by the several oils after 10 days' exposure to copper and 24 days' exposure to iron, according to Watson:

	Copper.	Iron.
Linseed oil	0·3000 gr.	0·0050 gr.
Olive oil	0·2200 "	0·0062 "
Almond oil	0·1030 "	0·0040 "
Colza oil	0·0170 "	0·0800 "
Castor oil	——	0·0048 "

Carpenter is inclined to distrust these figures as being any indication of corrosive action of the oil itself, and attributes the effects either to the presence of mineral acid employed in refining the oils or to free fatty acids engendered by fermentation in the oils.

Having now noted the chief qualifications to be borne in mind, it will help the reader to append a few tabulated statements concerning the most important vegetable oils, comparing them with animal oils used as lubricants.

I.—VISCOSITY.

(*a.*) Tested by passing similar quantities through the same aperture at different temperatures. (Allen.)

Name of oil or fat.	Number of seconds required. At 60° F. (15½° C.)	At 120° F. (49° C.)	At 180° F. (82° C.)
Vegetable.			
Olive oil	92	37·75	28·85
Rape oil	108	41·25	30·00
Animal.			
Sperm oil	47	30·50	25·75
Lard oil	96	38·00	28·50
Neatsfoot oil	112	40·25	29·25
Tallow oil	143	37·00	25·00
Engine tallow	solid	41·00	26·50

(*b.*) Tested by passing a drop down an inclined plane.

Name of oil or fat.	Distance traversed.	Day on which the oil ceased to travel.
Vegetable.		
Olive oil	1 ft. 9½ in.	9th day.
Rape oil	1 ft. 7¾ in.	8th day.
Linseed oil	1 ft. 6¼ in.	7th day.
Animal.		
Sperm oil, common	5 ft. 8 in.	9th day.
" best	5 ft. 6¼ in.	7th day.
Lard oil	11¾ in.	5th day.

II.—SOLIDIFYING TEMPERATURES.

Name of oil or fat.	Thickens at.	Solid at.
Almond oil	14° F. (—10° C.)	—13° F. (—25° C.)
American nutmeg oil		110° F. (44° C.)
Beech oil	14° F. (—10° C.)	0° F. (—18° C.)
Ben, oil of	59° F. (15° C.)	
Castor oil	5° F. (—15° C.)	0° F. (—18° C.)
Cherry oil		15° F. (—9½° C.)
Cocoanut oil		61°64° F. (16°18° C.)
Colza and rape oils		21° F. (—6° C.)
Cottonseed oil		34° F. (1° C.)
Dilo oil	50° F. (10° C.)	25° F. (—4° C.)
Gingelly or sesame oil		32° F. (0° C.)
Gold of pleasure oil		—2° F. (—19° C.)
Ground nut oil	37½° F. (3° C.)	25° F. (—4° C.)
Hazel nut oil		14° F. (—10° C.)
Hempseed oil	5° F. (—15° C.)	—13° F. (—25° C.)
Linseed oil	0° F. (—18° C.)	—4° F. (—20° C.)
Madia oil		14° F. (—10° C.)
Melon oil		6° F. (—15° C.)
Olive oil	50° F. (10° C.)	
Poppy oil		0° F. (—18° C.)
Tobacco oil		6° F. (—15° C.)
Walnut oil	5° F. (—15° C.)	—1·° F. (—27° C.)

There is one very important vegetable oil which has been omitted from the foregoing tables on account of its differing from most plant oils in being solid at ordinary European temperatures. This is palm oil, a product of the outer fleshy coating of the fruits of several kinds of palm, but especially of *Elæis guineensis*, a native of western tropical Africa. Genuine palm oil has, in this climate, a buttery consistence; it is yellow colored, of mild flavor, and smells like violets; it loses color in the sun, soon turns rancid, saponifies easily, and dissolves readily in ether and alcohol of 0·848 sp. gr. Its qualities differ widely, according to the locality of production; but they remain fairly constant for each particular port. This is a highly important matter for the consumer. Oil shipped at Lagos is the cleanest, least rancid, and almost the softest; "Brass" oil is nearly as pure, but the hardest of all; "Cameroons" and "Windward" oils are of medium quality as regards both cleanness and hardness;

"Saltpond" and "Monrovian" oils are particularly dirty. The cleanest and least rancid oil is alone admissible for the preparation of railway grease, as the reader will infer from what has been already said about acidity arising from fermentation in the oil itself.—*Industries.*

[NATURE.]

POWER IN LABORATORIES.

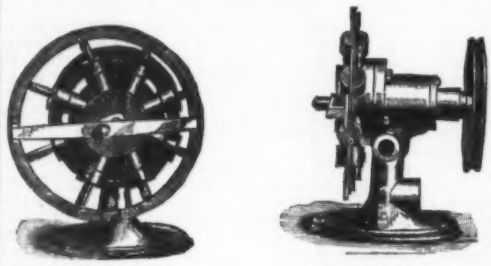
ONE of these motors is set up in the cellar of our science hall, where it is supplied with aqueduct pressure of sixty pounds to the square inch, and the power is transmitted from it by means of rubber belting led over "idle pulleys" to the upper stories of the building, where a small engine lathe and dynamo are driven. A word will suffice to explain the very simple construction of the motor—a system of radial cylinders, with their bases at the center of the motor, through which runs the driving shaft. The pistons in these cylinders are single acting, and the water is admitted to them in succession by the rotary valve which forms part of the main shaft. The pistons, thus, in pressing outward exert their force against a strong ring, to which is bolted a cross bar which engages the crank of the main shaft. Thus the ring, in turning the shaft, has the vibratory motion of an eccentric, and returns the opposite pistons to the bases of the cylinders, at the same time exhausting the water through the interior of the rotary valve. Three pistons are thus constantly exerting a thrust upon the ring, whatever its position, and this thrust being always tangential to the arc of revolution of the crank, there is no "dead center," and the uniform pressure at right angles to the crank at every part of its arc insures an even rotary motion, and obviates the necessity of a balance wheel. The ends of the piston-rods are slotted, and contain anti-friction rollers which bear against the ring, and this latter is grooved all round, so that, in addition to its simple and rapid motion as an eccentric, the ring is free to perform a slow motion of revolution independently of its work of driving the crank, and the wear of the interior face of the ring is thus equalized and becomes inappreciable.

The supply-pipe for this motor has a diameter of 1¼ inches, and it gives an equivalent of nearly two horse power. The flow of water is regulated by means of a balanced valve, under control from every point where the power is used. As the use of the power is for the most part discontinuous, like that in lathe-work, I find it better to start and stop the motor as often as desired than to use the ordinary device of shifting a belt off and on a loose pulley. All possible economy of water is assured, as none of it runs to waste without giving its equivalent of power at just the time when it is required. It will be seen that this form of motor is specially adapted to such uses, as there is no fly-wheel whose inertia has to be overcome; and as the motor has no "dead center, it readily starts from any position, overcoming a maximum resistance.

Where continuous running is required, at an invariable speed, a centrifugal governor is attached to the belt-wheel, and acts upon the amplitude of vibration of the ring, diminishing the stroke of the pistons when the resistance is removed. The governor thus gauges the water supply exactly proportional to the resistance to be overcome, and makes the motor a very effective driving power for dynamos and all sorts of machines and apparatus in which a uniform speed is necessary, while the resistance is variable.

The difficulties barring the economic use of water as a motive power, owing to its weight and incompressibility, seem to have been successfully overcome in this form of motor, with which unexampled speeds have been attained, and more than 80 per cent. of the theoretical power of the water derived. The little cut annexed shows the smallest size of these motors; it stands about 10 inches high, and uses a ⅛ inch supply, consuming less than six quarts of water in 100 revolutions. I frequently run it at a speed of 1,000 revolutions to the minute, and at the manufactory I have seen the same motor attain double this velocity. The motor runs equally well with compressed air or with steam, if the piston packings are changed, and with either of these media even higher speeds are attainable.

I find that the constant readiness of the motor for



SIDE VIEW. FRONT VIEW.

the immediate development of power, the little care it has required (only occasional oiling), and its economical consumption of water, are very great advantages in its favor; and, for all laboratories supplied with aqueduct pressure, I venture to think that it affords the best solution of the problem of inexpensive, convenient, and effective power.

DAVID P. TODD.

Lawrence Observatory, Amherst, Mass., May 15.

HOW TO MAKE RUBBER TYPE.

THE process is a simple one: The matter or letters to be reproduced are first set up in clean-cut metal type, which is then thoroughly oiled. A rim or guard about half an inch high should then be placed around the form, and with a camel's hair brush a thin cream of plaster of Paris is laid over it, to exclude all air bubbles. A thicker paste of plaster is then poured over the form, filling in the guard or rim up to its edge, and it is then set aside to harden. Alum water is often used to mix the plaster, as this makes a harder mould, but it takes somewhat longer to set. When the mould has thoroughly stiffened, it is removed from the type and placed in a dry, hot place to become well hardened. The mould is now fitted in a frame of suitable size, and a sheet of vulcanized rubber, about one-eighth of an inch in thickness, is adjusted upon it, and the whole is put in a screw-clamp and heated slowly until the rubber becomes soft enough to be forced into the letter spaces of the mould by tightening the screw. The rubber should be allowed to remain in the press at least twenty-four-hours, and until it becomes quite cold. The sheet-rubber used for this purpose is usually but slightly vulcanized, having had about 3 per cent. of sulphur kneaded into it with rollers while subjected to a very high temperature. After the impression has been made, therefore, it is necessary to add a greater proportion of sulphur, to insure the required hardness in the type. This is done by immersing the rubber, which has been separated from the mould, in a mixture of 30 parts bisulphide of carbon and one part chloride of sulphur. This is exposed to a temperature of from 70 to 80 degrees, until all the sulphide of carbon has volatilized, and is then immersed in a boiling alkaline solution—made by dissolving nine ounces of caustic potash in one gallon of water—for a few minutes, and after a subsequent washing in clear, tepid water, is made quite ready for use.—*Inter-Ocean.*

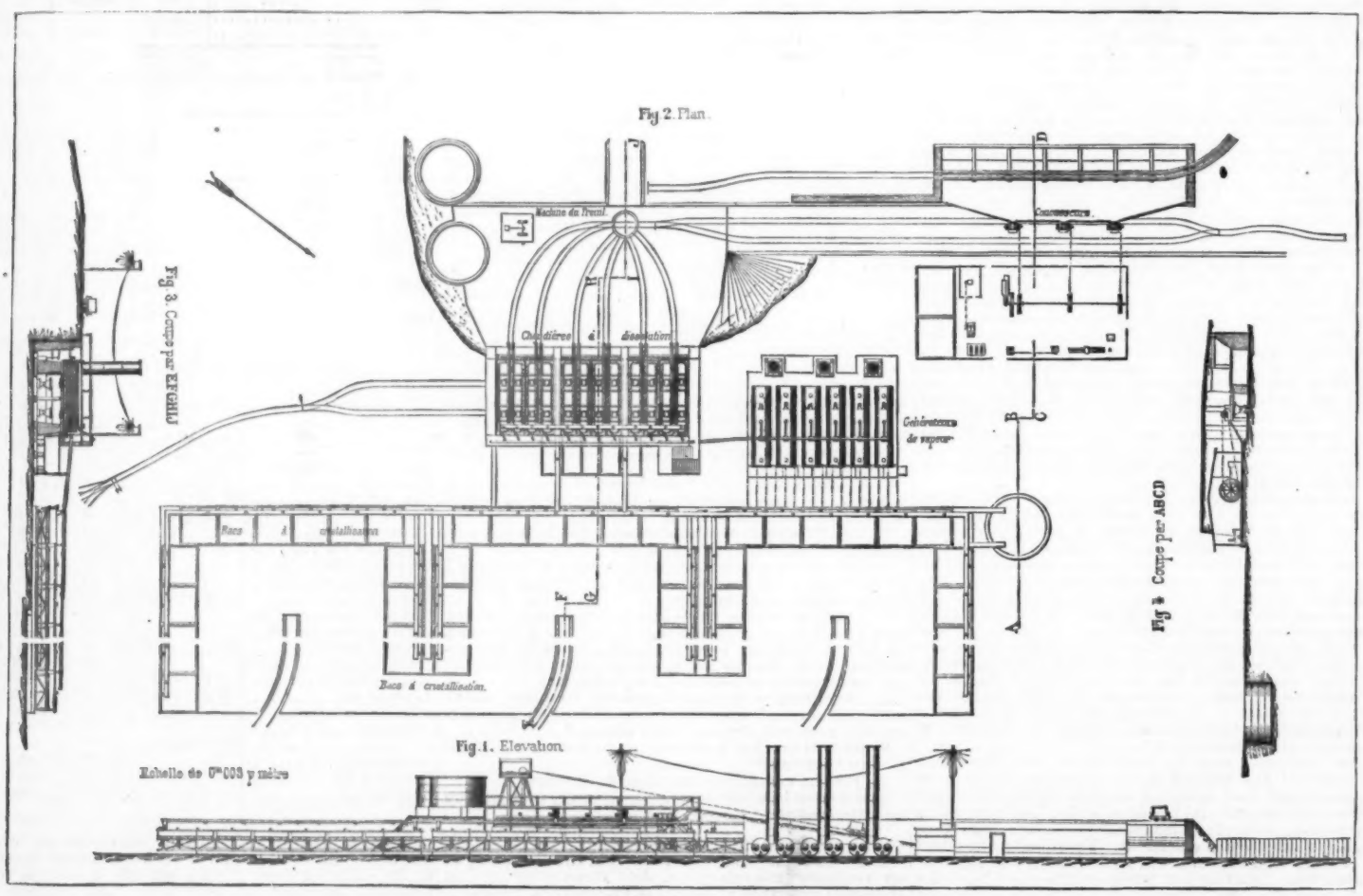
THE MANUFACTURE OF NITRATE OF SODA IN CHILI.

THE manufacture of nitrate of soda by the treatment of *caliche*, or impure nitrate, has, during recent years, become largely developed in the provinces which were recently ceded by Peru to Chili, and which, between the 19th and 27th degrees of south latitude, contain the only known deposits of this product, or at least the only ones worked. We borrow from a memoir by Mr. Robert Harvey a description of one of the largest Chilian plants, that of Ramirez, and of the processes employed thereat.

The formation of caliche beds is attributed to the decomposition of animals and vegetables in contact with saline deposits left by the sea. In support of this opinion there is cited the frequent presence of birds' skeletons, shells, fish, guano, and the eggs of sea birds in the vicinity of the deposits of caliche, even at a depth of 10 or 15 ft. under the surface, and also of iodine in the form of iodate of soda.

The richest deposits are situated upon the border of the Tamarugal pampa, in the province of Tarapaca. The depth of these varies between 6 inches and 12 feet, and they are covered with conglomerates or a crust of porphyry, and sometimes of gneiss and syenite. The Ramirez deposits cover an area of 2,600 acres. They skirt the pampa, and are situated 57 miles from the port of Iquique by rail, and 40 miles by direct mule road.

The extracting is done in quite a primitive way. A well one foot in diameter is sunk through the stratum of caliche to the underlying earth. Then a child is let down, who forms at the bottom a conical hole, which he fills with a slow-burning powder manufactured at the works. An ordinary fuse brings about an explosion which breaks up the deposit within a radius of 30 ft. The upper rocky crust is then removed and the caliche extracted. This latter is divided by the jumper and hammer into 25 or 30 pound blocks. The crude product contains about 51 per cent. of nitrate of soda, 26 per cent. of common salt, 6 per cent. of sulphate of of soda, and 3 per cent. of sulphate of magnesia. The remaining 14 per cent. consists of earth and insoluble matter. The Ramirez works are designed for a monthly production of 6,300 tons. The extent of this exploitation has led to an abandonment of the mode of carriage (mule carts) employed in the other establishments, and to the substitution of portable tracks upon which run two locomotives having four coupled wheels and a bogie truck. The cylinders of these engines are external, and are 8 inches in diameter for a 14 inch stroke. The driving wheels, which have forged iron rims and steel spokes, are 33 inches in diameter. Those of the bogie are of cast steel, and are 17¾ inches in diameter. Each engine weighs, in service, 7 tons, and carries 225 gallons of water and 550 pounds of coal. The portable track is of the Greigh type. It is wholly of steel. The



A CHILIAN NITRATE OF SODA PLANT.

minimum radius adopted for curves is 59 ft., and the maximum gradient is 3·15 per cent. The cars, which are side-tilting ones, are 80 in number, weigh 1,300 pounds, and carry a ton and a half of caliche. There are usually 15 cars to a train. This entire plant takes the place of 220 mules and 35 carts. There are employed in addition 30 mules and 5 carts for carrying the material to the railway.

The caliche, coarsely broken *in situ* into 25 or 30 pound blocks, is carried by the trains to the stamping mills, which break it into pieces two inches square. These mills are three in number, and are actuated by a 25 h. p. Tangye engine. Cars arranged around them receive the material, and are hauled up an inclined plane by a windlass to a turn table (Figs. 1 and 2), whence they are sent to the dissolving boiler. The treatment consists in dissolving the caliche in the mother-water derived from preceding treatments, and allowing the solution to crystallize. There are twelve dissolving boilers, each heated by a steel worm of six spirals, in which circulates steam at four atmospheres produced in steel generators. The steam enters at the upper part of the worm, and the water of condensation returns to the generators. These latter, which have a double firebox, are 6½ ft. in diameter and 29½ ft. in length. They are arranged in pairs, each of which has a smokestack 42 ft. in height and 5 ft. in diameter.

The circulation in the boilers proceeds in a methodical manner. As soon as the solution marks 110° by the Twaddell densimeter, the steam is shut off, and things come to a standstill for a quarter of an hour, when the liquid is allowed to flow into a conduit, from whence, through secondary pipes, it reaches the crystallizing backs. Its temperature is then 115°. The residuum is washed with water, and the latter, which contains nearly all the remaining nitrate of soda, is sent to a special reservoir, from whence it is taken by a centrifugal pump and forced into the nearest dissolving boiler. When all the wash-water has been expelled, the boilers are opened and the residuum is thrown into the cars, which carry it to the dump-heap.

The crystallizers are ninety in number. They are 15¾×15¾ ft., and have a depth of 3 ft. at one side and of 2¾ at the other, so that the precipitate may be thoroughly drained. These backs are supported by a framework of Oregon pine. Under each of them there pass six joists, whose ends carry a platform which serves as a passageway for the workmen who attend to the precipitation.

After the cooling of the liquid and the crystallization, the *agua vieja*, or mother-water, is drawn off through a conduit which leads it to a cylindrical reservoir 24½ ft. in diameter and 12 ft. in height, placed on a level with the ground. From this it is pumped up for feeding the dissolving boilers. It generally marks 90° Twaddell.

The products of crystallization are afterward spread over a floor with shovels and allowed to dry in the sun. Then they are put into bags, in order to be sent to Iquique, the shipping port for Europe and the United States.

The residua still contain 3 per cent. of nitrate, the greater part of which might be extracted by further washing; but this would perceptibly reduce the concentration of the mother-water, and the evaporation would thereafter become more costly.

During the last six months of 1884, the production reached 12 tons of nitrate per ton of coal consumed.

The supply of water, which must be large, as well for the production of steam as for that of the mother-water and the washing of the boilers, is secured by two wells 235 ft. in depth, and 9×10 ft. in section, lined with planks which are held in place at intervals of four feet by a wooden framework, which at the same time carries a guide for the pump rods. The lifting apparatus consists of three Tangye pumps, and each well is capable of furnishing 7,050 gallons of water per twenty-four hours. The water is supplied by the melting of the snow of the Cordilleras. The flow of this is very irregular, and some works have to go five or six miles for their supply. That of the Ramirez wells is fortunately nearly inexhaustible, but the pumped liquid contains alkaline salts that would necessitate the cleaning of the generators every two months. So for feeding the generators and for domestic purposes, only the water of condensation of the engines can be used.

As the work goes on during the night, the grounds are illuminated by two 6,000 candle power arc lamps, supplied by a Siemens dynamo, of the type A, actuated by a four horse power Tangye engine.

Foundations constructed in ground strongly impregnated with salts and soluble materials required special precautions, for the introduction of water into the subsoil, even in small quantity, would have led to dangerous subsidences, destroyed the level lines of the motors, and injured the shaftings. In the first place, an excavation 12 ft. in depth was made over an area of 837 sq. ft., an area nearly three times greater than occupied by the structures, which cover but 335 sq. ft. The bottom of this excavation was covered to a depth of two feet with a layer of broken conglomerate, in the interstices of which was poured a mortar composed of one-third Portland cement, one-third hydraulic lime, and one-third sand. Over this was spread a layer of beton eleven inches thick, formed of hard broken stone and a mixture of cement and sand in equal parts, then other courses of good masonry.

It is upon this foundation that rests the main walls, whose height is 12 feet, whose thickness at the base is 6 feet, and at the top 3½, such a batter having been adopted in view of the effects of earthquakes. The dissolving boilers are supported by a framework of Oregon pine, resting upon masonry 2½ feet in height built within the space inclosed by the walls, and parallel with the latter. The wooden framework carries 24 metallic girders, of 10×10 inches section, and 33 feet in length, upon which the boilers are bolted.

The internal walls have considerable of a batter in order to allow of the flow of the liquid due to leakage at the base of the boilers. This liquid is collected in drains whose incline is such as to lead it to a general channel, and from thence to a special reservoir. Three parallel walls, built in part of the main ones, support the wash-water reservoir, which is divided into five 6½×23 feet compartments. The crystallizers are supported by pile work resting upon low walls, whose foundations are simply of dry stones, as the mother-water or nitrate in solution does not attack the earth.

All the motors, generators, and heating apparatus were brought from England, save the stamping mills, which were furnished by a Tarapaca concern.

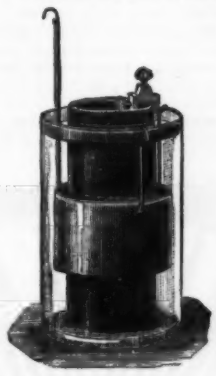
The first cost of the establishment was $550,000, including, besides the shops and the apparatus just described, the buildings necessary to shelter 600 workmen and their families. The erection of the works and setting them running required only six months, despite the difficulties due to the distance from any large city.

The general production of nitrate of soda of the province of Tarapaca, which was only 6,000 tons in 1845, the epoch at which the means of extraction were of the most primitive character, and at which the product was, as yet, but little used as a fertilizer, successively rose in 1859 to 70,000 tons, and in 1883 to 570,000.

The various plants, united, might supply much more yet, but they have been obliged to form a syndicate in order to hold back the production in proportion to the demand, which, from Europe, does not exceed 400,000 tons. The rate of reduction is now 40 per cent., and the Ramirez works are employing but 300 men instead of the 600 that were counted upon.—*Le Genie Civil.*

THE DUN BATTERY.

THE inventor of this new battery, patented by the firm of Schaefer & Montanus, of Frankfurt, has endeavored to apply as a depolarizing agent the well-known properties of permanganate of potash. The positive pole of this element is formed by a hollow cylinder of coke, fitted with a bottom and partly filled with small coke. The negative pole is formed of a cylinder of zinc surrounding the former and separated



from it by two rings of caoutchouc; the whole is contained in a glass vessel.

The permanganate of potash is introduced into the cylinder of coke, and the entire element is filled with a lye of caustic potash in the proportion of one part of potash to five of water. The permanganate dissolves in the potash, and acts as an oxidizer and depolarizer on the surface of the coke.

In the state of rest this battery is not impaired, and the zinc consumed will be always proportional to the quantity of electricity produced; lastly, there is no escape of gas.

The constants of a Dun element of the size of an average Bunsen are: electromotive force, 1·8 volts; current on short circuit, 15 to 20 amperes; internal resistance (calculated), 0·09 to 0·12 ohm. After 30 to 40 minutes on short circuit the electromotive force falls to 1 volt, and the current to 8 or 10 amperes, an intensity which it then retains for a long time. The element is regenerated after one or two hours' rest, and recovers the electromotive force indicated. In the case of the production of feeble currents, the depolarization is complete and the element is constant.

The exhausted liquid, which contains the zinc consumed, may then serve for coating metals with zinc, especially iron, without the need of an auxiliary battery. An electrode of zinc and the object to be coated are sufficient.

This battery should be recommended to galvanizers, who at present employ chiefly the Bunsen battery, the use of which, independent of its inconveniences, is much more costly.—*Elec. Review.*

A NEW FIRE ALARM.

IN America there are no large cities in which burglar, fire, and other alarms are not in common use, and most insurance companies stipulate that they shall be put into the building insured. It may certainly be ob-

FIG. 1.

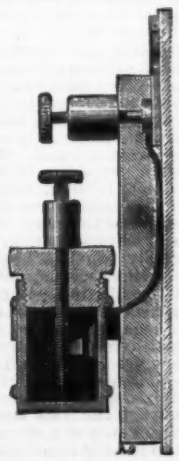


FIG. 2.

jected that the frequency of robberies and fires among our neighbors across the ocean necessitates precautions that are, fortunately, less indispensable in France; but when we reflect upon the services that these low priced and easily put up apparatus are capable of rendering, we see that there are many cases in which the simplest prudence dictates their application.

Fire alarms may be classed in two categories—those which operate through a contact with the flames, and those which operate through a mere rise of the temperature. Among these latter there are some which operate only in case of an abrupt rise of the temperature—an advantage that we believe to be of little interest. One of the most recently patented arrangements, particularly recommendable by reason of its great simplicity, is that of Mr. Rouley's. This consists (Figs. 1 and 2) of a metallic cup, *a*, of a few cubic centimeters capacity, lined internally with some insulating substance, such as wax, paraffine, or the like. The degree of fusion of this coating corresponds to the dangerous temperature at which the alarm is to be given. The cup also contains a few drops of mercury, into which dips a metallic rod, *e*, covered with an insulating substance.

It may be readily seen that any number of these apparatus may be interposed in the electric circuit of a call-bell, and that the circuit shall remain always open in a normal state, and close only at the moment the insulating material melts. At this moment the bell rings and announces the danger.—*La Lumiere Electrique.*

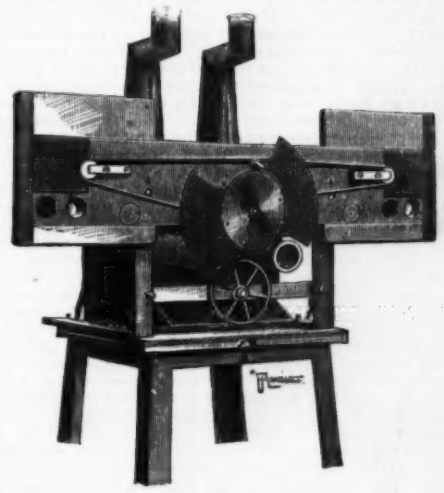
A NEW FORM OF STEREOSCOPE.*

By A. STROH.

TWO optical lanterns are placed side by side, as for dissolving views. Two transparencies, photographed in the same manner as if intended for an ordinary stereoscope, are placed one in each lantern, and projected on a screen in such a position that they overlap each other as nearly as possible. The picture which is intended to be seen by the right eye may be placed in the right-hand lantern, and the other in the left.

Supported by suitable framework, and in front of the two lenses of the lanterns, is a revolving disk, portions of which are cut away, so that during its revolutions it obscures the light of each lantern alternately, or, in other words, so that only one picture at a time is thrown on the screen. A continuous change from one picture to the other is thus obtained.

In the same framework, and in convenient positions for the observers, two pairs of eye-holes are provided,



one pair on either side of the apparatus. Behind each pair is also a rotating disk, and these disks are connected by suitable wheelwork or driving bands with the one previously mentioned, in such a way that the three disks rotate together, and at the same rate. The two last-named disks are also so cut that they will obstruct the view through the right and the left eye-holes alternately.

Finally, the connection between the three disks has to be so arranged that the time of obscuring the view through the right eye-holes or the left eye-holes shall coincide with the time when the light is shut off from the right or left lens of the lantern respectively.

It is obvious that by this arrangement an observer can only see the picture projected from the left lantern with the left eye, and the one from the right-hand lantern with the right eye. The rotation of the disks must be of such a rate that the alternate flashes of the right and left pictures on the corresponding eyes follow in such rapid succession that the impression made by one flash does not diminish sensibly before the next flash on the same eye is received. The number of flashes for each eye which is required to produce an apparently continuous view, without any flickering effect, is from 30 to 40 per second. As the disks are so cut as to produce two flashes for the right eyes and two for the left in one revolution, they must consequently be kept rotating at a rate of from fifteen to twenty revolutions per second.

The rotation of the disks is effected by a driving wheel and band, worked by a crank handle at the back of the apparatus. The perspective effect obtained by the above arrangement is very perfect, the image of each object standing out in solid relief. Considering that by this arrangement the two eyes never see at the same time, and that each eye views its picture after the other, it is interesting to find that the persistence of vision so completely bridges over the alternate interruptions to which it is subjected as to produce the effect of a continuous view.

The advantages claimed for this form of stereoscope are that the pictures can be enlarged to such an extent as to appear equal, or even larger than the original objects from which they were taken; and that the eyes, in looking at the pictures, are not in any way subjected to strain by lenses, prisms, or reflectors, or by the difficulty which some persons experience in getting the two pictures to superpose. For each eye views its corresponding picture in exactly the same position it would see it in if it were looking at the original, since the two pictures are practically in the same place, which

* Abstract of a paper read at the meeting of the Royal Society, April 1, 1886.—*Engineering.*

is not the case in any other form of stereoscope. Although with the apparatus as here described only two persons can see the pictures at the same time, it would not be very difficult to construct it so as to be available for a greater number. The side disks above described only serve to control one pair of eye-holes each, but by making them larger they would serve for two pairs each, thus accommodating four observers. By increasing the number of disks, the number of observers might be increased proportionally.

TEST THE CHROMATIC SENSE.

By C. S. JEAFFRESON, F.R.C.S.E., Surgeon to the Northumberland, Durham, and Newcastle Infirmary for Diseases of the Eye.

EVERY instrument which tends to simplify and render more easy the functional examination of the eye is a great boon to the ophthalmic surgeon, not only by enabling him to do his work with less fatigue, but by facilitating the conduct of inquiries upon a much larger scale than is possible when the means at his command necessitate complicated apparatus or a lengthy system of examination. These remarks specially apply to the perception of colors. Within recent years, defects in the color sense, whether congenital or acquired, have assumed an importance which can scarcely be overestimated; the former chiefly in connection with the recognition of lights and flags in the railway and marine services; the latter in connection with the different forms of amblyopia dependent upon diseases of the optic nerves and the various parts of the brain which constitute the visual centers.

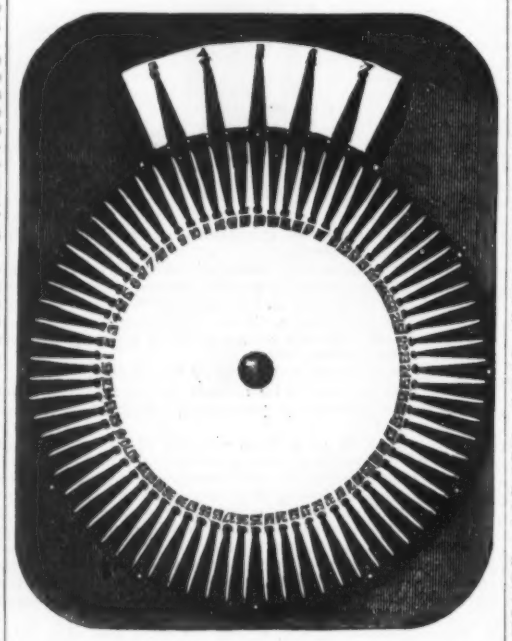
It is not my purpose here to discuss the various theories which have been advanced in explanation of the phenomena of color perception, but to introduce to the notice of the profession a piece of apparatus which I have had constructed with a view to the rapid detection of errors in this direction. Most of the methods in general use are either too complicated or not sufficiently efficient. Holmgren's is, of all others, perhaps the most convenient, but, carried out with the detached skeins of wool, it is tedious in its application and requires a good deal of talking and explanation. The wools, too, require constantly remixing; they are apt to be thrown about or mislaid; and, withal, there is no ready method of keeping a record of the colors that have been erroneously selected by those who have a defective chromatic sense. This system therefore is ill adapted for the out-patient department of a hospital. What is required is some instrument which, always at hand, can be rapidly and efficiently applied with the minimum loss of time, and these attributes I claim for my instrument. The principle is essentially that of Holmgren, but the application is somewhat modified for the sake of rapidity and convenience.

The instrument consists of a test board and a revolving color disk. The disk consists of a white enamel tin plate twenty-two inches in diameter. Its margin is cut out or notched so as to form altogether 72 bobbins or winders to hold the skeins of different colors. The wool when placed upon these winders passes through an aperture which is situated opposite the center of each notch; it thus assumes the form of a cone, the apex of which is directed toward the center of the circle, the base occupying the extreme margin, as clearly seen in the annexed sketch, where the shaded cones represent the colors. The test board, which is fixed and immovable, consists of a segment of a circle, also enameled, so placed that its concavity exactly fits the convexity of the disk. Winders to hold the test colors are let into this tin plate in the same way as upon the disk, but the bases of the cones are directly toward the concavity of the test board, the apex outward. In this way the base of any color cone on the wheel can be placed in exact apposition with the base of any color cone upon the test board, forming with it a figure of this form: $\frac{\triangle}{\triangledown}$. The disk rotates upon its center, and by means of a weak catch stops when the bases of the cones are exactly opposite the bases of the cones on the test board. The colors that have been selected for the test board are the colors of the spectrum: red, orange (yellow), green, blue, and violet; and purple has been added, with a view to enable the tests to be applied upon Holmgren's principle. The green is the pale green which represents his No. 1 test; the purple is the tint which represents his test No. 2; the red is the full red which represents his test No. 3; the blue is a pure saturated blue, neither inclining to red nor green; the violet is a pure violet, as near to spectral violet as can be obtained. These test colors are arranged upon the board and numbered as follows (there is no No. 1 or No. 2, for reasons which will follow): No. 3, pale green; No. 4, purple; No. 5, red; No. 6, blue; No. 7, orange or yellow; No. 8, violet. Upon the circle there are in all 72 colors, and they are numbered as follows: 1 to 19 represent the lighter shades of confusion colors; 20 to 29, the darker grays and browns; 30 to 36, greens of various shades; 40 to 46, purples of various shades; 50 to 56, reds of various shades; 60 to 66, blues; 70 to 76, yellows and oranges; 80 to 86, violets. To scatter the colors and yet to preserve some kind of order, the numbers do not follow each other consecutively on the circle, but in the following order: 1, 10, 20, 30, 40, 50, 60, 70, 80* (which represent one of each of the series of colors); then Nos. 2, 11, 21, 31, 41, 51, 61, 71, 81 (which represent another series), and so on in succession; each series as much as possible representing darker shades as they progress toward the higher numbers. In this way no two colors of the same hue come together upon the circle, and they appear generally scattered, although really a definite order is preserved. Now, with this arrangement it is easy to register and keep a record of the color defects a person who is examined may show; so that we may, as it were, subsequently examine him without his presence, and study carefully his defects.

Let us now explain how the circle is used. A test color (whichever is desired) is shown to the patient, and he is directed to look at it carefully, and then gradually and slowly turn the wheel until a color which to his eye corresponds, although of a lighter or darker shade, comes immediately above it, and completes the figure which is formed by the junction of the two cones at their bases. When he is convinced of the correspondence, *he is to remove his hand completely from the wheel*, and the examiner then notes the number of the color chosen. Now, in recording the cases, if we write down the number of the test as a numerator and the numbers of the colors chosen as denominators, we shall find that, in accordance with the arrangement of the colors and their numbering, in a person with normal chromatic sense, the first number of the denominator will always be the number of the numerator, because the different shades of each color are grouped in series of tens—the greens are all under 30, the purples under 40, the reds under 50, and so on, their corresponding test number being 3 for green, 4 for purple, 5 for red, and so on.

Let me give a few practical illustrations. A patient presents himself. Test 3 (the pale green) is given him. He stops the wheel only at 30, 31, 32, 33. C. S. = $\frac{3}{30 \,.\, 31 \,.\, 32 \,.\, 33}$. In other words, his color sense is normal. Another patient presents himself. No. 3 is given to test. He selects 1, 5, 7, 6 (confusion colors). C. S. = $\frac{3}{1 \,.\, 5 \,.\, 7 \,.\, 6}$. He must therefore have dyschromatopsia. Has he partial achromatopsia? No. 4 is now given him to sort (purple). He stops the wheel only at the series of $40 - \frac{4}{41 \,.\, 43 \,.\, 44}$. He has no partial achromatopsia. Had he stopped the wheel at 60 (blue) or 80 (violet), his color sense would have been recorded $\frac{4}{41 \,.\, 43 \,.\, 60 \,.\, 80}$, and he would have been suffering from red-blindness, according to the Young-Helmholtz theory. Had he selected with Test 4 any of the series of 30 (greens), or any of the darker grays contained between 19 and 29, he would have been green-blind, according to the same theory, and his case might be thus recorded: $\frac{4}{40 \,.\, 30 \,.\, 24 \,.\, 27}$.

I need not multiply these illustrations, as far as the other tests are concerned. Any one who is acquainted



with Holmgren's system will see how they can be applied and recorded according to the plan I have laid down. A glance at the diagram will render easy of comprehension the somewhat complicated verbal description which has been found necessary. The instrument has been carefully and elegantly prepared by Messrs. Picard & Curry, the well-known opticians, of Great Portland Street, London. It works smoothly and well, and should, I think, find a place in the consulting rooms of both the physician and ophthalmic surgeon, railway offices, recruiting depots, private and public schools, and other places where the testing of the color sense is a question of interest.

It has been urged as one of the chief features of Holmgren's system that the hand and eye combine together to reveal the defect of color sense in patients who are submitted to this form of examination; the hesitancy and vacillation of their movements in selecting the skeins giving a clue to the deficiencies of their perceptive color functions. In using the color circle, these maneuvers between the eye and the hand lose nothing; I think, indeed, they become more conspicuous, and frequently enable us to detect a color-blind person at a glance. A person with normal chromatic vision, who has had the operation of the wheel explained to him, will sit down and go through the various tests in less than a minute. A color-blind person seems to shrink from the wheel; when he sits down to it, he turns it with hesitation, and in a few seconds usually convicts himself. There may be a difficulty sometimes with stupid persons, as there are in all forms of examination; but we must beware of those who *pretend to be stupid*, and who, in reality, are deficient as regards their color perceptions, but hope to escape by leaving the examiner under the impression that they are lacking in intelligence. The examiner should not lose patience with this class, but should carefully explain what is wanted of them, and should himself go through the tests with the wheel. A person who is stupid only will at once see what is required, while one who is color-blind will receive no assistance by seeing the examiner sort the colors.—*Lancet.*

* By a mistake of the engraver, the numbers are erroneously placed on the block.

ROOT BEER.—Take 1 oz. each of sassafras, allspice, yellow dock, and wintergreen, ½ oz. each of wild cherry bark and coriander, ¼ oz. hops, and 3 qts. molasses. Pour sufficient boiling water on the ingredients and let them stand 24 hours, filter, and add ½ pint yeast, and it is ready for use in 24 hours.

THE "HALIBUT" OF THE GREAT LAKES.

By G. ARCHIE STOCKWELL, M.D., Port Huron, Mich.

FEW of the finny tribes are possessed of such marked economic value as the sturgeons; and one of the family, at least, is often valued at its weight in silver rubles. The flesh of all possesses greater or less excellences in that it is firm, white, and well flavored, being often likened to veal, and even its superiority thereto asserted. The roe, denuded of its membraneous covering, and salted and packed, becomes a most marketable product under the name of *caviar*. The air-bladders produce a superior form of isinglass, and the cartilaginous skeletons and skins are capable, respectively, of being transformed into the most clean, pure, and white of gelatin and glues. In Russia, and many portions of northern and eastern Europe, entire populations are engaged in, and supported by, the sturgeon industry alone, which is held of greater practical importance than salmon fishing, and is moreover more certain and full in pecuniary returns.

Most fish of this family are found in the Black Sea, the Sea of Azov, and the rivers flowing into them; and the common sturgeon of Europe (*Acipenser sturio*) is found in the Mediterranean, the Adriatic, Atlantic, North Sea, and especially abounds in the Baltic, ascending the rivers in large shoals to spawn at certain seasons of the year; though never beyond certain fixed points, limited, doubtless, by food supply. It acquires a goodly size, varying from six hundred to one thousand pounds; while a near relative, the *A. huso*, the sturgeon of the Danube, frequently doubles the extreme of these weights, having been taken of twenty-five hundred pounds. Owing to long-continued and constant persecution, however, the latter is at present somewhat rare. The sterlet (*A. ruthenus*), of which so much has been said and written, as commanding a value greater even than the "king of fish," and as being the favorite among the epicures of the Muscovite empire, rarely measures above two, two and a half, or at most three feet, and is never found weighing above eight or nine pounds. An American gentleman, having tasted sterlet for the first time, thus unbosoms himself: "Its unapproachable flavor is supposed to be as evanescent as the hues of a dying dolphin. Frequently, at grand dinner gatherings, it is carried around the table in a little tank, and exhibited *alive* to the guests when their soup is served, that its freshness, ten minutes afterward, may be put beyond suspicion. It has all the appearance of a small, lean sturgeon, but its flesh resembles the melting pulp of a fruit rather than the fiber of its watery brethren. It sinks into juice upon the tongue like a perfectly ripe peach. In this quality no other fish in the world can approach it." Recent attempts to propagate this species artificially have succeeded in North Germany; and as it thrives well in fresh water alone, we may yet hope to have it added to our Great Lake fauna, though not until fish laws are more decided in character, and made operative in application. It stays longer in the rivers than other sturgeon, and requires gravelly reaches for spawning, with a considerable fall. Sparsely found in the Danube as far as Bavaria, in the Sulzach, the Drau, and other tributaries, as well as the Dniester, it is held to reach its perfection only in the purer and colder waters of the Volga.

The sturgeon of the Great Lakes (*A. rubicundus*) is pre-eminent in point of size among fresh-water fishes, and is *claimed* to attain a length of twenty and twenty-five feet, though in reality rarely averages above two or at most three yards. He is but a cousin of several removes to the creatures that wallow about the estuaries and tide waters of the Western Atlantic (*A. oxyrhynchus* and *A. brevirostris*), and claims but spare relationship with the shovel-nosed "hog" fish* (*seuphirhynchops, plutyrhynchus*) of the Mississippi, Missouri, and their tributaries, and is much more cleanly, aristocratic, and reputable than either. He has a neat, rather trim body, in spite of a half-swinish contour; and his flesh, clear, white, firm, when properly prepared, is of delicious flavor. He produces also a clear, almost odorless, oil, of especial value in the arts, the better grades being monopolized by the Eastern markets, whence it returns again as "walnut oil," or, after undergoing reclarification, in modest little vials whose capacity is entirely incommensurate with their size, put up for the benefit of watchmakers, jewelers, and sewing-machine dealers, with labels certifying the contents as "pure porpoise" or "refined winter-drawn sperm" oil. Another grade, and one which is secured in part from offal and viscera, finds ready sale among those who prepare "*pure*" and "*Norwegian*" cod-liver oils for the nourishment of the strumous, the rickety, and consumptive, and is equally desirable, and meets all the requirements of the genuine article.

For so large a fish, the Great Lake sturgeon is wondrous shy and timid, and very dainty in choice of food. He seldom or never preys upon the smaller tribes, though sometimes devours their spawn when opportunity offers; and his conduct is that generally of a good citizen of the aqueous commonwealth in which he resides. What his infantile and youthful habits of life may be I cannot conceive, since I do not remember ever having seen one of less than three feet in length; nor have I, during a residence of thirty-five years on the Lakes, ever been fortunate enough to fall in with one who has. Like Topsy, he appears to have "just growed"—sprung into existence all at once, as it were, from the tiny eggs that are scattered each June along the clay banks of rivers and lakes. Says Mr. James Milner, of the U. S. Fish Commission: "Among many hundreds of sturgeon of different sizes brought in from the nets and landed, while we were visiting the fisheries of Lakes Michigan, Superior, Huron, and Erie, not a single specimen was seen of a size of a yard or less; and if the young are not represented in these, they are not taken by the seines, pound-nets, or gill-nets that gather in fishes from all parts of the lakes and streams." It is conceded, however, that those fish possessed of long and slender snouts, and who present marked keels or ridges upon the plates of the head and back, are more youthful than those with smooth, keelless shields and blunt, obtuse noses.

Formerly, the Great Lake sturgeon was held in uni-

* The existence of this creature in the Great Lakes was long mooted, but was finally confirmed by the capture of a "spoonbill" near Sarnia, in 1883, which found place at the International Fisheries Exhibit at London, England, the same year. Two specimens have also been taken in Chautauqua Lake.

versal abhorrence and contempt and hatred, as a destroyer of nets, save by the Indians and their Gallico-American imitators; and because the Canadian Creole or "Habitan" would eke out his scanty fare and keep Friday with *Nishe-Nahma*, or "*bœuf de poisson*," in our boyish ignorance he was wont to be classed with the Chinaman of Peter Parley, who, we fondly imagined, was accustomed to dine off rats, lizards, fat puppies, and last year's birds' nests. With years of discretion, however, I have learned that very palatable *bouillon* may be prepared from this fish, a little too rich, perhaps, for ordinary use, but if carefully skimmed of the oil it might readily be mistaken for chicken broth, since it has not the slightest fishy flavor; and most excellent pickled meat is made by boiling and preserving in vinegar.

Some thirty-three or thirty-four years back, a colony of Mormons took possession of one of the Beaver Islands of Lake Michigan—the "Pig Beaver"—under the leadership of one James J. Strang, or, as he styled himself, "King James the First," and whose court was established at the present hamlet—for it has grown no larger—of St. James. In winter this island was entirely cut off from communication with the mainland and outside world, and partially so even in summer, since northern Michigan and Wisconsin were yet the homes of the moose, cariboo, wapeti, beaver, and wolf; and consequently the saints frequently suffered for the necessities of life, and more than once were at the verge of starvation. Finally, Strang conceived the practical idea of teaching his subjects to live as did their aboriginal neighbors upon the contiguous islands and mainland. The latter caught the sturgeon, which is especially abundant in the vicinity, ate him, and waxed sleek thereon. Conveniently he received a communication from "on high," whereby *Nishe-Nahma* was declared above all others the favorite fish of the Almighty, and commended by Him to His "chosen people;" and his majesty set an example by requiring sturgeon to be served upon his table thrice daily in two or more forms. Later, he engaged a portion of his subjects in curing, drying, and smoking the fish, whereby its superior excellences were made manifest without further divinical suggestion; and thus were the seeds sown of what is now one of the greatest and most remunerative of Great Lake industries. To-day, Ohio, Michigan, and Wisconsin rival all Muscovy and Scandinavia in the production of *caviar*, that for the most part is exported to Europe; and Racine, Milwaukee, Grand Haven, Port Huron, and Sandusky market more cured "halibut"* than Gloucester, Newburyport, Swampscott, Marblehead, and Salem, and the supply in no way equals the demand. Strang also discovered the superior properties of sturgeon oil, and secured its adoption at many of the Government lights along the Lakes, where it was adjudged superior to the best sperm, in that it gave a larger and whiter flame, and consequently clearer and brighter light, with but trifling smoke or waste, and clogged neither wicks nor machinery.

The mode of capture adopted by the "saints" was a modification of that generally in vogue among their copper-hued neighbors, and one that still obtains to a considerable extent in winter, when the use of pound-nets is precluded.

In winter, sturgeon are inclined to lie motionless, and in half-torpid condition, along the sandy reaches and clay bottoms of the rivers and lakes. This may be due in part to insufficient oxygen in the water, to their gross condition—for they are now at their very fattest and best—or perhaps to some lingering tendency toward hibernation. Especially is this noticeable in the deep waters about the Fox and Beaver Islands, more particularly in the vicinity of Hog and Garden Islands of the latter group. The moment an opening is made through the ice, however, all the sturgeon in the immediate vicinity appear to be aware thereof, and for a time will gather about it, pushing, struggling, and jostling, in their eagerness to secure a sniff of the outer air. Why this is so I am unable to explain, except conjecturally; and if it be not in obedience to a physical demand for a better and purer supply of the respiratory gases, it remains one of the unanswered problems of fish-life. At all events, it is a fortunate trait for the fisherman, and one of which he is no way backward to take advantage. He makes a series of openings, each at some distance from its fellow, that one may, perhaps, secure him employment when others are shunned by the shy and restless fish; and frequently several series are made a mile or more apart, since, if one series is deserted, the sturgeon are sure to seek another. Fresh air appears to present attractions as irresistible to the species as the rum bottle to the habitual toper.

When engaged in fishing, the opening is strewn about with a quantity of cedar or hemlock brush, as an antidote to possible frost, upon which the fisherman reclines at full length, his head and the hole alike shrouded under a heavy blanket, that effectually shuts out light, save the little that, due to refraction of water, struggles feebly up from below. By this means it is not only possible for the eye to command to advantage an extended area of water, but to penetrate to the bottom, even at thirty and forty fathoms in some instances, while the observer himself is wholly invisible to those whose lives he seeks. And now, woe to the sturgeon that passes that way, or that is found within the limits of vision and range of that spear whose murderous barbs are propelled with astonishing accuracy and dexterity to his wounding. A prolonged but useless struggle follows, terminating only when the iron is drawn or the fish is dragged to the surface and lifted to the ice to breathe out his life, and freeze, while awaiting his captor's pleasure.

The weapon employed is entirely unlike any other implement of the class with which I am familiar, and consists of two parts—the handle, by which it is manipulated, and the spear proper. This last is a pointed rod of round "*five-eighth*" or "*three-quarter*" steel, a foot to half a yard in length, armed with from three to six barbs, ranged successively one above the other on the same side; at the junction of the middle and upper third it is flattened, bulged, and drilled, to form an eye, into which is knotted one end of a stout cotton cord of some thirty or forty fathoms length, whose original inception was the support of mattresses or the drying of linen; the other or proximate extremity being fastened to the ringed projection of an iron ferule shrunk about the middle of the handle, into whose larger end the harpoon or spear fits loosely by means of a socket shouldered and supported by a stout metallic band. The shaft of the weapon is always of some hard and heavy wood that will penetrate the water easily and deeply, as hickory or black ash, is of enormous proportions, in that it is from 25 to 35 feet long, according to the ability of the individual who wields it, and two to two and a half inches at the butt. This arrangement is pre-eminently suited to the object in view, insuring the capture of the heaviest fish with but a minimum expenditure of time and muscle; for few are capable of the exertion demanded to hold a lively and vigorous sturgeon of two or three hundred pounds, especially should the iron penetrate the middle and "broad" of the back, where the creature obtains the advantage of indirect power and broadside assistance; and even were such possible, the handle would be apt to come to grief in a struggle carried on at such manifest disadvantage as through an opening in the ice of but eighteen or twenty inches diameter. But, the point becoming disengaged the moment the barbs are sent home, a cumbersome and unwieldly shaft, so essential to striking, is returned, withdrawn, and cast aside, while the line, its slack previously coiled upon the ice or held conveniently looped in the left hand, secures to the fisherman perfect control of the captive, including the necessary amount of play. It is grudgingly payed out, or the slack rapidly taken up, as occasion demands or permits, always preserving marked strain, until the exhausted fish finally submits itself to be drawn to the opening and lifted out. Sturgeon from six to eight feet long are readily taken in this way, and even colossal individuals of three, four, and five yards, who have long since outgrown their youth, and are in the midst of a truly patriarchal longevity. In summer, especially in the rivers and vicinity of their spawning beds, they are sometimes speared from boats or canoes; but this is by no means a frequent practice in the Great Lake region, though common enough, I believe, in the waters of the British Northwest, and must be attended with no little danger and exertion.

Of late years, the majority of sturgeon marketed are taken in the spring and autumn by means of nets—pound or stake nets and seines. Formerly their feeding grounds and spawning beds were universally avoided, for they were not only a nuisance in that they supplied no demand, but they endangered the nets; and, moreover, they were falsely accused of driving away the better fish. These same spots now, however, are the theaters of many exciting scenes and contests, and the great fish are drawn to the strand by seines, gaffed, and lifted bodily into wagons or the holds of small, decked-over sail boats, known as "hookers," to be transported to the "wait ponds" and curing houses. They are a hardy fish, moreover, and withstand a deal of abuse and ill treatment, being more tenacious of life than almost any other species, the dog-fish and lake "cats" excepted, perhaps, and when removed from water will give evidences of vitality for many hours. On many occasions I have witnessed wagon loads of these monsters, piled four and five deep, passing along the street, a majority, if not all, alive, though taken from the water the evening previous; and once a sturgeon to all appearances dead, and that had been overlooked and buried in the sand for nearly thirty hours, made a speedy recovery after being rolled into a pool left by the receding lake!

Those engaged in curing sturgeon find it convenient to build what are known as "*wait ponds*" wherein the fish are preserved alive up to the moment of slaughter. It is believed that the flesh of the creature deteriorates, and that its value is correspondingly impaired, if there is the slightest delay between killing and placing in the pickle that embraces the first stage of the "halibut" transformation. These ponds are merely areas of lake or river inclosed on three sides by driven piles, planked upon their interior in a manner that will insure free circulation of water, the bank, clay by preference, supplying the remaining side of the quadrature. Most of these inclosures, since they are usually in the vicinity of well-known and established resorts of the species, are provided with one or more gates, nicely adjusted and balanced, and that swing outward and downward upon a mud-sill, in order that boats may pass in towing seines laden with fish. Four or five thousand sturgeon in one pond is no unusual sight, and I have often been assured of double the number in the pen of a dealer on the St. Clair River, a little below the outlet of Lake Huron. The principal fishing grounds are Sandusky, Maumee, Monroe, and Pigeon Bays on Lake Erie; the entire coast of Lake St. Clair and the lower portion of the river of like name in the vicinity of Algonac and Harren's Island; lower Lake Huron as far north as Saginaw Bay; this bay proper including the lesser ones of Thunder and Tawas, and the waters about False Presque Isle; Green Bay; the "Beavers," off Racine, Waukegan, Grand Haven, and the mouths of the Calumet, St. Joseph, and Kalamazoo Rivers of Lake Michigan, and the vicinity of Ashland Bayfield and the Apostle Islands and Chaquegamon Bay, Lake Superior. Few are taken in the latter lake, however, not on account of deficiency of supply, but chiefly because the energies of fishermen are directed toward the capture of higher valued food fish—whitefish, trout, and siscouit.

For so large and seemingly gross a species, the sturgeon is an exceedingly clean and dainty feeder. His food for the most part consists of small *crustaceæ* and *invertebrates*, notably of the family of gasteropods, the thinner shelled of which, as *Physa*, *Planorbis*, and *Valvata*, are found broken in the stomach, while *Limnæa* and *Melantha* remain whole. A few eggs of fishes, including those of his own species, are sometimes observed, but never in quantities sufficient to justify the designation of "spawn eater." His strong, blunt, swinish snout is especially formed for rooting, ending as it does in a dense, compact, cartilaginous mass, the inner and spherical layer of which is in great request among Canadian-French lads as a nucleus for the lacrosse ball, to which it imparts a solidity and elasticity unattainable by any other substance, not even *caoutchouc*. Ask any fisherman how the sturgeon sustains life, and the answer will be invariably, "*By feeding upon air, water, and mud*," or that he is a "*wind and mud-sucker*"! Absurd as this appears upon its face, it is nevertheless true, though scarcely in the sense implied or understood. The creature certainly does grovel and root in the mud, as the clay banks of the "wait ponds" afford ample evidence; and, as fast as the earth is loosened, it is drawn into the mouth, tempered with water, the minute forms of life therein separated and swallowed, when all remaining is ejected.

So far as I have been able to discover, the sturgeon plays the host to none of those disgusting forms of life that infest the intestines of other and oftentimes better food fishes, and his only parasite is the silver lamprey eel (*Ammocetes argenteus*), which is sometimes found very firmly attached to his skin; and circular scars and ulcers that sometimes appear are attributable alone to this pest.

Though the sturgeon industry is remunerative, it has already reached its limit; the fish are abandoning their accustomed haunts, while in some instances, especially where pound nets prevail, are almost extinct. This would matter little, however, were they left unmolested in June and July, during the spawning season, when they gather in the shallows to roll, leap, and tumble about as in play, and are most unrelentingly persecuted. But long after the Great Lakes are exhausted, the waters of British America will afford abundant supply.

* Locally, no attempt is made to deceive, and sturgeon is simply *sturgeon*, and as such is preferred to *Hippoglossus maximus!*

THE JAY COLLECTION OF SHELLS.

WOLFE MEMORIAL GIFT TO THE AMERICAN MUSEUM OF NATURAL HISTORY.

PERHAPS no branch of natural research affords more pleasant occupation than the study and collection of shells. To wander along the shores of our coast, gathering the curious and beautiful waifs which the tides or waves have thrown up on the sands, to man a skiff, and with dredge and tassel explore the hidden life which beneath the sparkling waters of bay and gulf is swarming in myriad forms, is a pleasure whose very mention brings the odor of salt brine to our senses and fills our ears with the rhythmic beat of breaking billows.

The variety of life thus encountered is bewildering; the sea contains in its depths and shallows representatives of every division of the animal kingdom, and in its vast domain embraces an extent of varied forms which appeal both to our sense of the grotesque and the beautiful. Here we may study with the microscope the minute organisms whose flaming orbs in great masses give the phosphorescent flashes to the midnight sea, the *Noctiluca*, while the lovely shapes and colors of jellyfish (*Ctenophoræ*) and sea anemones (*Medusæ*), the plant-like, arborescent forms of the "squirrel tails" (*Sertularia*), the eccentric and attractive starfishes and sea urchins, the hordes of funny crabs and scuttling lobsters, with their numerous allies and congeners, the infinite diversity of finny occupants, the singular annelids, and the vast armies of molluscan life, form quickly changing and intermingling groups which are seen at once, and fill the collector's pails and baskets with specimens and species which it will take the quiet of long winter evenings to classify and name.

Shells form so obvious a class of objects, are intrinsically so interesting, and are so readily preserved, that most visitors to the seaside collect them to some extent, while those who pursue their study in the widest sense find their attention quickly absorbed, to the exclusion of the other realms of nature. Visit a shell cabinet of any size, and to one accustomed only to see the pale gray and white, light purples, and ephemeral yellows of our coast shells of this latitude, the brilliancy of the color display is amazing, and the multiplicity of shapes even more pleasing. Here are groups of *cones* with nacreous and pearly tints and beautiful tesselated markings, *volutes* with waving lines of ornamentation, coral-red *pectens*, white *spondyli* with extravagant frills and tortuous spines, golden *cypræas*, the colored convolutions of the *trochus*, the cavernous and daintily stained *strombi*, the elegant *phasianellæ*, the queer *limpets*, the ornate and richly sculptured *harpæ*, the architectural *scalariæ*, pheasant marked *tritons*, the huge cassis with its orange mouth, and the scarlet mouthed *helices*.

Such a collection of diversified characteristics, and representing a worldwide geographical distribution, is in process of permanent arrangement in the halls of the American Museum of Natural History. When completely labeled, it will form probably the most accessible cabinet of such dimensions which the public can use in the United States, and should stimulate the study of conchology in our neighborhood. The collection was made by Dr. John Jay, largely by purchases, and attained some celebrity in connection with the vast amount of labor expended on its catalogue, and because a large number of the *unias* or fresh water clams were used by Dr. Lea in his monograph on this family of shells, as well as for the frequent references made to it in the pages of special writers.

A very broad and natural distinction, which divides the entire order into two great divisions, is noticeable at once in any collection of shells, viz., the bivalved and the univalved shells; and this separation results necessarily from a structural contrast of importance. The two-valved shells, like our common clam or oyster, have two articulating shelly disks, which interlock at or along one edge and inclose the soft membranes of the animal between them, while the one-valved shells are simply a single shell case, of varying forms, in which the animal resides, and from whose opening or edge it protrudes itself when engaged in feeding or when in movement. Very generally the univalve shells, like the common "drill," are spires which the organism has formed as it has wound around upon itself in its increasing growth, expanding and enlarging, while a rudiment of the second valve, always present in the bivalved species, is suggested by a door or *operculum*, which, attached to the foot of the creature, is drawn tightly against the aperture when it retreats within its house. These shells, which we so frequently refer to as the habitation of their inclosed organisms, are really external skeletons. The soft integument which embraces the viscera of the mollusk is called the *mantle*, and this secretes about the growing animal the nacreous and shelly films which, thickening and hardening, form the adult shell. This shell has been slowly secreted in organic cells, which, massed together along the growing edge of the older parts, have become filled with carbonate of lime, and are finally solidified with the former, to be succeeded by new lines and areas of similar solidifications, and the tiny capsule or embryo enlarges in widening circles into the mature *exo-skeleton* or shell.

When the shell is dissolved in acid, an animal residuum is left, and this felt-like organic substance represents the framework through whose interstices the shelly tissue was deposited. It is termed *conchioline*.

The structure of shell is quite varied, and has been termed *porcellanous* when it has a luster, like marble or china; pearly or *nacreous*, *fibrous*, *horny*, *glassy*, when its texture has these characteristics. In the first form of shell, the component layers are variously arranged in three zones, as you might bank together three sets of cards, the central being transverse, the other sets vertical, or the outer transverse and the central oblique.

Through the increasing interest in the subject, conchological publications have so rapidly multiplied, researches and results have been so incessantly recorded, that large libraries are needed to supply the student with the necessary literature for their identification and discussion. Miss Catherine Wolfe of this city, well known for her generous gifts, has furnished the American Museum with means to complete the handsome conchological library she donated many years ago, in memory of her father, the Museum's first president; and when the books are all purchased, the collection and its library will form a unique feature for public instruction.

The distribution of the molluscous tribes is brought about by two agencies principally, the active habits of locomotion in the young of many species and the drifting of individuals in the oceanic currents; to be sure, many travel slowly considerable distances, as the river mussel, which pulls itself along over the oozy banks of streams, the scallop, which leaps as it opens and shuts its vibrating valves, and the gasteropods, which crawl upon their undulating fleshy disks; but tidal motions of the water effect those wide ranges which ally the faunæ of separated continental areas. It has been more than once pointed out that migrating birds will assist such distributions, as it has been recorded that bivalves have attached themselves to the feet of aquatic birds, from which they will detach themselves when the winged pilgrim settles upon the next hospitable stretch of water. As Woodward says: "In the sea, each zone of depth has its molluscous fauna. The limpet and periwinkle live between tide marks, where they are left dry twice a day; the *trochi* and *purpuræ* are found at low water, among the sea weed; the mussel affects muddy shores, the cockle rejoices in extensive sandy flats. Most of the finely colored shells of the tropics are found in shallow water or among the breakers. Oyster banks are usually in four or five fathoms water; scallop banks at twenty fathoms."

Naturalists have defined a number of provinces which are distinguished by more or less characteristic groups of shells; these provinces unite sometimes along their edges, sometimes are sharply contrasted, and depend for their greater or less individuality upon the configuration of the continental coasts, the run of tides, and the character and depth of the ocean beds.

Thus, the Arctic province extends from Newfoundland northward on the American continent, and to Iceland and the North Cape in the transatlantic areas, its southern line being loosely limited to the southern boundary of floating ice; the Boreal province embraces the shores of Massachusetts, Nova Scotia, Faroe and Shetland Islands, and Norway. The Celtic province includes the shells of the British Islands, Denmark, Sweden, and the Baltic; the Lusitanian, those of the coast of Spain and Portugal and the Mediterranean, of which latter basin it is interesting to notice that the Atlantic shells prevail in its western extension, dying out more eastward, where exotic species from the Red Sea put in an appearance. The West African province in its tropical region possesses a rare abundance of beautiful shells, Strombus, Purpura, Triton, Nunex, Conus, and many other valuable genera. South Africa has been dignified as a province, though it possesses many of the shells of the next contiguous area, the Indo-Pacific, which are brought in tide-flows to within its limits.

The Indo-Pacific province is extensive, reaching "from Australia to Japan, and from the Red Sea and east coast of Africa to Easter Island in the Pacific" (Woodward). New Zealand and Australia form a district of conchological interest, having many shells living within its borders, only known fossil elsewhere. The Japonic, Californian, Panama, Peruvian, Magellan, Patagonian, and Caribbean form other more or less specialized areas, and furnish peculiar species or groups of species.

On our coasts hereabouts, the young collector will find access to three sorts of hunting grounds, which are again combined with one another, rocky, muddy, and sandy shores. On the first, attached to the rocks and mingled with the swaying, pendent masses of sea weed, he will gather, among many others, young oysters, the two species of mussel, barnacles, the little *littorinas*, the destructive "drill," which works its way into the shell of the young oysters and then feasts on the nutritious occupants, the purpura on exposed headlands, the jingle shells (*Anomia glabra*), the saxicava, which will burrow its way into limestones, and numerous crustacea; on muddy flats he will encounter the pretty bivalve *Clidiophora*, *Tellinas*, *Goldia*, and mussel, the larger Pholas, many softshell clams, and numerous gasteropods; while sandy shoals will supply him with specimens of the great *Fulgur*, the odd encrusting boat shells (crepidula), the fine robust naticas (*Lunatia heros* and *Neverita duplicata*), the razor shells, whose lightning-like rapidity of motion in the sand will astonish him, the innumerable Gemmæ, which fill the sand of shallow waters in places, so as to be more numerous than the sand grains themselves, the beautiful *pecten*, and strange and uncouth worms.

Such brief reflections on this absorbing study are suggested to the conchologist who reviews the brilliant cases of shell treasures on the floor of the American Museum of Natural History.

IRON AT ELEVATED TEMPERATURES.

M. PIONCHON.

ABOUT 700°, iron undergoes a modification characterized by an absorption of heat which is extremely rapid within an inconsiderable range of temperature. In the discussion on reading this paper, E. Becquerel remarked that iron, about 600°, presents another remarkable change in its physical properties, since the attractive action exerted upon it by magnets is then suddenly diminished. As nickel and cobalt, from a magnetic point of view, present effects of the same order, but at different temperatures, nickel at 400° and cobalt at white redness, it would be very interesting to ascertain if the thermic capacity of these metals does not undergo changes analogous to those of iron near those temperatures.

VENTRILOQUISM.

VENTRILOQUISTS may, according to their specialties, be divided into various categories. Some devote their talent to the imitation of the cries of animals, the songs of birds, the noise of tools, etc.; others imitate the sounds of musical instruments; some mock the noise produced by a crowd, a regiment, or a procession; while others, again, make dolls or dummies speak.

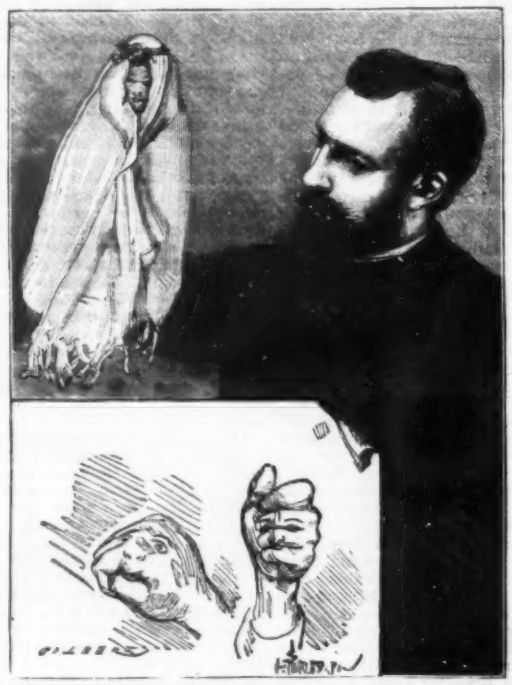


FIG. 1.—METHOD OF MAKING FACES WITH THE HAND.

The following little story told by the Greek authors will be recalled just here. In a sort of competition between an actor and a peasant, in which it was a question of imitating the cries of a pig, the crowd decreed the prize to the actor, and hissed the peasant; but the latter, opening his cloak and showing a pig, began pulling the animal's ears, and thus showed the audience the error that it had just committed.

In our own day, we quite often see ventriloquists exhibiting in public and imitating the cries of the most diverse animals, such as the hog, the ass, the horse, the dog, and the cat, as well as the language of the entire population of the poultry yard.

Among such ventriloquists, we may class those who imitate the songs of birds, especially the song of the nightingale, and who, in scenes that are sometimes charming, almost succeed in producing a genuine illusion. Mr. Fusier, a well known actor, has a very remarkable talent for imitating animal cries, and apropos of this there is an anecdote told which is amusing, if not altogether authentic. It appears that the janitor of this gentleman's house, having several times heard strange cries in his apartment, went up stairs to protest against the violation of the conditions of his lease, which stipulated that the tenant should keep neither dogs nor cats in his rooms, and certainly no hogs, asses, and other animals, such as the janitor accused Mr. Fusier of harboring.

Certain ventriloquists imitate the sound of musical instruments, from that of the violin up to that of brass instruments with the most piercing notes. Others excel in imitating the noise of the plane, saw, etc.

As an example of the illusion that can be produced in this line, the English author Stewart, who devoted himself to ventriloquism, speaks of an individual who imitated to perfection the sound of the north wind blowing through the crevices of a door or window. He says that he has often seen this man play this trick in the corner of a cafe, and rarely failed to observe some one get up to see whether the doors were tightly closed, while others who were in a mood for reading a paper contented themselves with putting on their hat, raising their coat collar, or buttoning up their coat to the chin.

Certain ventriloquists, while hidden by a screen simply, have the faculty of making their audience believe that several persons, or even a crowd, are in the vicinity. The celebrated mystifier Mr. Vivier was a very skillful ventriloquist, and succeeded in producing very curious illusions while hidden by a screen in a drawing room. Sometimes he imitated the march of a regiment; giving the sound of the clarion and drum, the timed tread of the soldiers, the orders of the officers, the exclamations of the crowd, and so forth.

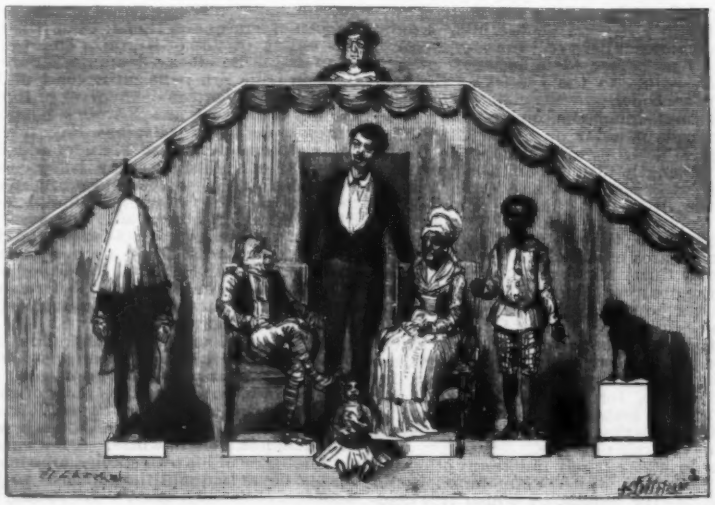


FIG. 2.—O'KILL AND HIS FIGURES.

At the beginning of this century, a ventriloquist named Fitz-James excelled in this sort of accomplishment. For example, he imitated the noise made by a procession of monks under the vaults of a cloister, and in which were heard not only the murmur that a large crowd always produces, but also the grave voices of the choristers and the sharp voices of the children. The auditor imagined himself to be at a few yards from several hundred persons, and experienced a genuine surprise when the ventriloquist reappeared alone in front of his screen. There are large numbers of examples of modern ventriloquists who, like the magicians of antiquity, have made either animals or inanimate objects talk. Mention has been especially made of several practical jokes of this nature that were performed by Mr. Comte, a prestidigitator, while director of the Theatre des Jeunes Elèves. This person was a skillful ventriloquist. At a village fair one day, he put words into the mouth of a hog that an old woman had just sold; and the unfortunate animal, accused by the crowd of being nothing else than a sorcerer, was dragged by the ears before the mayor by the rural guard. The hog stopped his cries only to call his leader "idiot," much to the latter's alarm. At Tours, he was the cause of the front of a long-closed shop being opened, by his making heard within the latter the voice of an alleged individual who was imprisoned therein. At Nevers, a peasant seated upon an ass suddenly heard the latter protest against the bad treatment to which he was subjected, and, being nearly frightened to death, took to his heels and left the animal, which he believed to be bewitched.

These bad jokes of Comte's often got him into great danger. At Fribourg, for example, he was arrested by some peasants, who accused him of sorcery, and wished to burn alive in a furnace; but a formidable voice that

issued from the furnace mouth put the peasants to flight.

From time to time, one sees the performances of the "man with the doll" announced upon the programmes of the variety theaters. Mr. Bouchotty, "the man with the doll," is a skillful ventriloquist who carries in his arms a doll simulating a four or five year old girl, and holds a very amusing conversation with it.

At the end of the last century, a ventriloquist of Vienna, Baron Mengen, acquired a great reputation by similar performances. It is related that, at one of his exhibitions, an Irish officer was so thunderstruck at the wonderful things that he had just witnessed that he jumped for the pocket into which the Baron had put his doll, whereupon the latter began to utter piercing cries, as if it had been badly hurt. The officer, surprised and alarmed, let go, and the Baron, taking the doll from his pocket, showed that it was made of a rudely carved piece of wood covered with a mantle.

At Egyptian Hall, London, we recently saw a magician make his appearance upon the stage carrying a doll, with which he held a somewhat uncouth conversation. The lips of the doll were observed to move, and the illusion was complete, when all at once the doll's head was strangely transformed. The magician had just opened his hand, showing that it was the latter alone that—inclosed in a white glove upon which were a few colored marks—formed the doll's head.

In Fig. 1 may be seen two methods of arranging the fingers for forming a doll's head with the hand. The illusion is produced by making a few simple lines with charcoal, and wrapping a handkerchief or napkin around the hand; then, if one has a little aptness for ventriloquism, he may hold a conversation with the head.

In our time, most ventriloquists who exhibit in public considerably facilitate the illusion that they desire to produce by using large articulated dummies, which they make speak and sing, and talk to one another—each in a different voice.

These figures are so constructed that the ventriloquist's hands can move their arms and legs, turn their head to the right or left, give their shoulders a shrug, open or close their eyes, and move their lower jaw in such a way that their mouth seems to utter the words that the spectator hears.

Several ventriloquists have given exhibitions this year in the Parisian circuses and variety theaters, and, among these, a Mr. O'Kill "and his family." O'Kill's "family" was placed upon a stage, and the ventriloquist stood behind it, and made each individual speak in a voice peculiar to it (Fig. 2). One of the figures, representing a grotesque old man, had a strong bass voice; another, an old woman, a nasal voice; and the others, sharp or infantile voices. O'Kill made these move their head, arms, and legs. The figures disputed with each other, and sometimes showed themselves to be very badly brought up. Then they sang, either separately or in alternate couplets, as Mr. and Mrs. Denis. As a usual thing, while the figures were speaking and acting, the ventriloquist remained impassive, not a muscle of his face moving, or else he seemed to be listening to their discussions with curiosity, and to smile with interest at their jokes.

We may say, in a general way, that these ventriloquists, thanks to the use of their dummies, succeed in producing so complete an illusion that people are frequently persuaded that the voice heard actually comes from the mouth of the figure, and that it does not proceed from the ventriloquist standing near the latter, but from a confederate hidden somewhere about, whose voice is heard through the intermedium of a speaking tube.

There is one trick that always tends to confirm the spectator's illusion, and that is this: In the little prefatory speech that the ventriloquist makes, he gives out that he is a foreigner, and does not speak the language of his audience well; in fact, he expresses himself with difficulty and with a strong accent. His dummies, on the contrary, answer in very good French or English, as the case may be; and, when the auditors hear them, they are led to believe that ventriloquism counts for nothing in their answers or conversation.

Explanation of Ventriloquism.—The art of ventriloquism is primarily based upon an acoustic phenomenon—the difficulty that the ear experiences in determining the exact point whence comes the sound that it hears. That there is such an incertitude as to the direction of sounds is easily verified, and the following are a few cases in proof of it. Mr. Stuart Cumberland, a mind reader, who exhibited at Paris a few years ago, performed a little experiment in the drawing room, after his "second sight" seances, which usually resulted in surprising and amusing his auditors. In this experiment, a willingly disposed person, being seated in the middle of the room, allowed his eyes to be bandaged. Then Mr. Cumberland took a five franc piece and made it jingle by striking it with a hard object, say a key or another coin. The person submitted to the experiment then had to tell the direction from whence the sound emanated, and to give the distance at which it seemed to him to have been made. In almost all cases, the individual guessed a direction and distance very different from the real one, and the error, which was oftimes great, naturally provoked much hilarity from the spectators. Moreover, Mr. Cumberland, by varying the position of his hand in such a way that the latter formed a screen between the coin and the ear of the blindfolded person, caused the latter's perception as to the direction of the sound to vary, although, as a matter of fact, the experimenter had not budged from his first position.

At a soiree, we have seen a member of the Institute, who had cheerfully submitted himself to the experiment, extremely surprised, when his bandage was removed, at the gross errors in auditory perception that he had just committed. The illusion that it is thus possible to produce by varying the positions of the hand in which a coin is jingled is, in the main, analogous to that obtained through ventriloquism. Another example: If several persons be standing in the same line, at a few feet from a spectator, and one of them emits a prolonged sound—a vowel, for example, say *a a a*—that requires no motion of the lips, the spectator will be unable to determine from which of the persons the sound proceeds; or if, moreover, he tries to point the one out, he will be almost certain to commit an error, the person designated by him being the third or fourth to the right or left of the one who actually produced the sound.

In the choruses of operas, an endeavor is made to have an agreeable aspect in addition to vocal qualities; and, as a beautiful voice is not always accompanied with a pretty face, it often happens that in the first row of a chorus they will place pretty supernumeraries, who, although not obliged to sing, open their mouth and make believe pronounce words, while in reality the singing is being done only by their companions in the rear. This fraud is very rarely detected by the audience.

If a man standing near a child should, without moving his lips, speak with a squeaking voice, while the child was making believe pronounce words, it might easily be believed that the words heard were being spoken by the child. It is possible to teach a dog to open his mouth and follow the motions of his master's hand; and if the master be any sort of a ventriloquist, he can easily make believe that he has an animal endowed with speech.

The ventriloquist who, standing near his dummies, succeeds in keeping his facial muscles absolutely immovable while his figures become animate, and move their lips and seem to speak, produces such an illusion among the spectators by virtue of the acoustic principle that we have just noted, that is, the difficulty that the ear experiences in determining the precise point whence emanates the sound that it hears.

It is to be remarked that the chief difficulty in the art of ventriloquism is to keep the countenance immovable, and to speak without causing any of the facial muscles to act.

The ventriloquist who talks with a dummy that is interrogating him, addresses his questions in an ordinary voice, articulates distinctly, and plainly moves his lips; but, when the dummy answers, the ventriloquist's face no longer contracts, and his lips scarcely part except to smile. The facial immobility preserved by him while he is really speaking, then, can be explained by recalling a few principles of grammar, which are merely applications of the physiology of the voice.

Articulate speech, which separates the language of man from that of the lower animals, is divided, as grammar teaches, into sounds and articulations. The sounds or vowels are made up of all the continuous and uniform noises that the vocal organs can emit. Thus, *a*, *e*, *i*, *o*, and *u* are vowels, because they may be infinitely prolonged; *a a a a a a*, for example. There are a greater number of vowels than is usually admitted in writing; it is possible, in fact, to modify them to infinity, so to speak, by a slightly more open or more closed sound. They may be classified in the form of gamuts, each having a typical vowel, the entire corresponding series of which is but the result of a more and more pronounced contraction of the lips, without the tongue and other vocal organs having to undergo the slightest modification. These type-vowels and their descending gamuts are shown in Fig. 3.

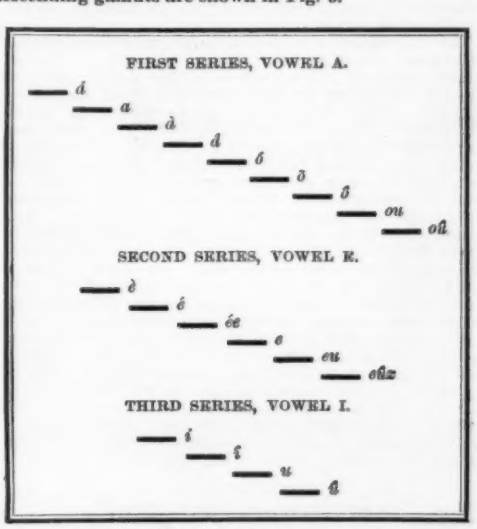


FIG. 3.—CLASSIFICATION OF THE VOWELS.

If in pronouncing each of these vowels, we draw the base of the tongue toward the back of the throat, without changing the position of the lips or tongue, we shall obtain the *nasal* sound thereof. The chief of such sounds are:

an, nasal sound of *a*;
on, " " *o*;

then,

en, *in*, nasal sound of *é*;
eun, *un*, " " *eu*.

The vowels *i* and *u* have no nasal sounds, because of the back position that the base of the tongue naturally occupies in pronouncing them, and which is but slightly modified when we endeavor to give them a nasal sound.

What precedes may be called the theory of the vowels. From the standpoint of ventriloquism, we must remark that, in order to pronounce the vowels, no motion of the lips is necessary; but it will suffice to allow the latter to remain slightly parted in order to give passage to the sound—this being generally done by ventriloquists through the aid of a smile, that seems to be provoked by the interest that he takes in the talk of his dummies.

All the modifications in the organs necessary for passing from one vowel to another, as in the diphthongs *oa*, *aé*, or when they suppress certain intermediate articulations, are easily obtained by the ventriloquist by the aid of the tongue and the interior organs of the mouth, without causing the lips and facial muscles to undergo the slightest motion or the least contraction, or, in other words, without any visible sign exhibiting itself to the eyes of the spectators. The pronunciation of the vowels, then, constitutes no difficulty for the ventriloquist. The same is not the case with the articulations or consonants, the pronunciation of some of which is a difficulty that the ventriloquist can overcome only by virtue of practice and skill, or again by an approximate pronunciation—the articulation difficult to pronounce without moving the facial muscles being replaced by another which gives nearly the same sound, but which is obtained with the internal vocal organs of the mouth.

The consonants may be classed by categories, according to the vocal organs employed for pronouncing them. In each category, they are divided into strong and weak, and, as regards ventriloquism, they comprise two series. A classification of them is given in Fig. 4.

FIRST SERIES.—CONSONANTS FORMED BY THE INTERNAL VOCAL ORGANS.	Strong.	Weak.
Gutturals	*c*	*g*
Palatal linguals	*l*	*ll*
Dental linguals	*r*	
Dentals	*t*	*d*
Palatal dentals	*n*	*gn*
Dental sibillants	*s*	*z*
Guttural sibillants	*ch*	*j*
SECOND SERIES.—LABIAL CONSONANTS.	**Strong.**	**Weak.**
Sibillant labials	*f*	*v*
Simple labials	*p*	*b*
Aspirated labials	*m*	

FIG. 4.—CLASSIFICATION OF THE CONSONANTS.

Upon examining this table, it will be seen that, in the entire first series of these consonants, the tongue, acting upon the pharynx, bearing against the teeth, or taking different shapes, can act and articulate without the aid of the lips, and without the necessity of the facial muscles contracting. The ventriloquist, then, will be able to pronounce any word in which none but these vowels and consonants enter, without moving his facial muscles.

The same is not the case with the consonants of the second series, that is to say, with the five labials F, V, P, B, M. The ventriloquist's art consists in pronouncing these without moving the lips or facial muscles. With a little practice, it is easy to reach such a result with F and V, which may be pronounced by causing only the interior muscles of the lips to act.

P and B, and M especially, present a greater difficulty, and we may say that, in most cases, ventriloquists who wish to keep their lips perfectly motionless pronounce none of these three consonants distinctly, but usually substitute for them a sound bordering on that of the letter N.

It is partly for this reason that ventriloquists succeed much better in imitating the language of children, or that of persons of slight education.

So, upon the whole, the illusion produced by ventriloquists is the result, primarily, of an acoustic phenomenon, the uncertainty of the sound's direction, and, secondarily, of a habit acquired of speaking without moving the facial muscles.

Those ventriloquists who, without accessories, have the power of throwing their voices almost anywhere, succeed therein by utilizing the same principle of acoustics that we have explained above. As for the exact point whence the sound proceeds, the ventriloquist usually takes care to show that by an expressive motion, and by looking in that direction, and by designating it, too, with his finger while his face expresses great fear, interest, or surprise. So the spectator easily persuades himself that the sound does really come from the exact spot that is thus pointed out to him in a seemingly unintentional manner.

The words are often pronounced very indistinctly by the mysterious voice, but the ventriloquist takes care, as a general thing, to render them intelligible by repeating them in his ordinary voice, by accenting them and by commenting upon them. He thus persuades his auditors that these are the very words that they heard.

In order to produce a muffled sound that seems to come from afar or from an inclosed place, the ventriloquist arranges his tongue in such a way that its base, upon bearing against the soft palate, shall form a sort of diaphragm that allows but very little of the voice to pass. If, then, the ventriloquist articulates his words with a strong guttural voice, the sound will appear to come from the earth, from a grotto or cavern, or from a box, or cask, or closet. If, on the contrary, the tongue being in the same position, the ventriloquist speaks with a sharp voice, he will produce the illusion of a voice coming from the ceiling, or from some high place, such as the top of a tree or the roof of a neighboring house. But, in both cases, in order to effect the emission of this muffled, somewhat indistinct, voice, the ventriloquist keeps his lungs distended, and emits as little breath as possible in pronouncing.

Richerand, the celebrated physiologist, who had an opportunity of examining the ventriloquist Fitz-James, says: "His entire mechanism consists in a slow and graduated expiration, which is, after a manner, protracted, and which is always preceded by a strong inspiration, by means of which he introduces into his lungs a great volume of air, which he carefully husbands."

As for the modifications to be introduced into the usual position of the organs in order to obtain the voices of aged people or children, hoarse or nasal voices, the cries of animals, sounds of musical instruments, the noises of tools, and so forth, they are easily effected, owing to the mobility, perfection, and resources of such organs; and it is by practice and feeling his way that the ventriloquist comes to know them and repeat them so as to obtain the voice that he desires, with certainty. Moreover, in order to get a good idea of the modifications that may be introduced into the voice by regulating the breathing, the opening of the pharynx, and the position and curvature of the tongue, it is only necessary to devote ourselves to this exercise for a few minutes, when the processes used by ventriloquists, and the illusions that it is possible for them to produce, will be easily understood. Perhaps, indeed, such an exercise will reveal to the experimenter that he has an aptness for ventriloquism that he was

far from suspecting. Let us recall, apropos of this, that Saint-Gilles, the grocer-ventriloquist of St. Germain, acquired his talent after less than eight days' practice, and that his celebrity, which dates back more than a century, has been perpetuated to our own day. —*La Nature.*

[ANNALS OF SURGERY.]

ON THE PRESENT STATE OF KNOWLEDGE IN BACTERIAL SCIENCE, AND ITS SURGICAL RELATIONS.

MICRO-ORGANISMS AND SUPPURATION.

A MOST valuable contribution has come to hand, being a prize essay furnished by George Klemperer, an undergraduate clinical student of the Berlin University, and published in the *Zeitschrift fur klinische Medicin.** The prize had been offered by the faculty in the hope of obtaining some further knowledge leading toward the definite solution of the vexed questions as to the relation of micro-organisms to suppuration, and the contribution under consideration may unhesitatingly lay claim to have elucidated some of the most important points of interest in these questions.

Under the heading above referred to, it was concluded, from the experimental evidence (Passet), that larger quantities of chemical irritants could produce suppuration, even when no bacteria were present; though Scheuerlen had proved that minute quantities (four drops) did not do so. In the present aspect of the subject, however, we are justified in declaring that there can be no suppuration whatever without micro-organisms.

Klemperer considered the precautions taken by previous experimenters (Uskoff, Orthmann, Councilman, Passet) to prevent the entrance of germs into the tissue cavity containing the injected chemical substance, to be uncertain and inadequate. He, therefore, adopted a method formerly used by Straus, of Paris, in 1883, consisting in the use of actual cautery to insure the disinfection of the skin and parts surrounding the place of puncture. After producing an eschar of about 2½ centimeters in diameter, with Paquélin's cautery, he introduced the canula of the sterilized syringe through the eschar beneath the skin, and again occluded this puncture opening with the cautery as soon as the injection was completed. Rabbits, Guinea pigs, and mice were thus experimented upon, and the substances injected were, of course, perfectly sterilized. Only in three cases the experiments failed, and pus containing micrococci was found. In all the rest—and a great number were performed—no sign of suppuration was observed, but only inflammatory symptoms were found, occasioning slight serous discharges, or, when potent chemical irritants (oil of turpentine, croton oil, mercury) were used, necroses of the tissues ensued, of the anatomical character of Weigert's coagulation-necrosis. The theorem may be, therefore, considered established, that micro-organisms are the cause of all suppuration.

We subjoin an abstract of the paper as given by the author himself.†

1. More or less grave errors can be pointed out in the experiments of such authors who claimed to have produced suppuration after injections of irritant chemical substances with exclusion of micro-organisms. Their results are therefore not correct.

2. Injections of alkalies, organic or inorganic acids, never produce suppuration, if micro-organisms be excluded.

3. Cantharides, ol. sinapis, petroleum, produce violent inflammation, but no suppuration.

4. Croton oil, oil of turpentine, and mercury are to be considered as producing the most intense inflammations. Injection of small amounts of these substances produces serous inflammation, if micro-organisms be absolutely excluded.

5. Larger amounts of oil of turpentine and croton oil in oily solutions, and mercury, produce coagulation-necrosis (Weigert) and fibrinous inflammation.

6. Injections of large amounts of turpentine and croton oil in alcoholic solutions produce serous inflammation, on account of the more rapid absorption.

7. Only in case micro-organisms enter under the skin after injections of turpentine, croton oil, and mercury, does suppuration occur. Micrococci can be observed in the pus in these cases, and they may be artificially cultivated, if they be inoculated into the soils before they lose their vitality.

To these results of his experience the author adds the following theoretical deductions:

8. Suppuration is occasioned by a quantitative as well as a qualitative alteration of the inflammatory process. The quantitative difference consists in the increased extravasation of white blood-corpuscles, as well as in the tendency of the process to spread, and in the general disturbance of the system frequently observed. The qualitative alteration consists in the purulent exudate remaining fluid, although all the substances necessary to the formation of fibrin are at first undoubtedly present.

9. Both these alterations in the character of the exudate in purulent as compared to other inflammations are to be accounted for by the vital characteristics of the micrococci:

(*a.*) Quantitative alterations.—The increased emigration of leucocytes and the general disturbance of bodily function is to be explained by means of the plogogenic or poisonous secretions or products of the cocci. The progressive tendency is due to the advance of the cocci along the vessels, etc.

(*b.*) Qualitative changes.—The fact that the pus fails to coagulate is occasioned by the want of fibrinogenic substance (one of the three generators of fibrin). This substance is probably converted into peptone by the cocci. That the latter can peptonize certain fluids has been proved as well as that pus contains peptone.

These latter considerations (Nos. 8 and 9) will, of course, be considered only in the light of ingenious hypotheses,‡ which future investigations will establish or refute. But it is not probable that the maxim advanced in this paper, that micro-organisms are the cause of all suppuration, will be again called in question in future.

* Die Beziehung der Micro-organismen zur Eiterung. Gekronte Preisarbeit. Vol. x., pp. 156–187.

† Centralblatt fur Chirurg., 1885, No. 51.

‡ The idea that peptone plays a part in purulent inflammation has been suggested by Landerer. Cf. this journal, vol. ii., p. 465.

Weigert* and Councilman† have previously pointed out that since the introduction of chemical irritants into the animal body does not occur outside of the pathological laboratories, it suffices for all purposes of practice to say that no suppuration occurs unless through the action of micro-organisms. This theorem is therefore not altogether new. But still, as long as we are under the necessity of explaining the toxic effects of septicæmic poisoning, etc., by means of hypothetical products of the micro-organisms, it appears natural to ascribe the phenomenon that pus does not coagulate, not so much to the mere presence of the micrococci in purulent inflammations, but to some chemical product of their vitalistic energies, which may possibly some day be artificially compounded in our laboratories, as Friedländer points out,‡ after the cultivation soils of such micrococci have been properly submitted to chemical analysis.

If we, however, accept the dogma that there can be no suppuration without micro-organisms, we must attribute all so-called eliminating suppurations, as in cases of necrosis, to the presence of micro-organisms as well, and not to mere lifelessness of tissue. This it appears natural to do, since we know that osteomyelitis, acute periostitis, etc., are actually caused by micrococci. If no micro-organisms are present, the necrotic portions of bone, etc., are absorbed, and dead tissues disappear by regressive metamorphosis without suppuration.

It might be objected that cold abscesses are known to contain no micrococci. But the chronic inflammatory conditions which lead to cold abscesses are all of a closely allied nature, and contain, if not micrococci, tubercle bacilli—even though the latter have not always been found in the pus.§

As to the forms of micro-organisims found by Klemperer in his experiments, he distinguishes three kinds, according to the effects which they produce. One kind is said to occasion only inflammation, another suppuration from the first, while a third variety possesses the property of converting existing inflammation into suppuration.

MICRO-ORGANISMS AND HEALTHY TISSUES.

The question whether micro-organisms are not sometimes present in healthy tissues has likewise been again thoroughly investigated in an experimental work by G. Hauser, of Erlangen,‖ with the result, which was to be expected after Koch's researches on the same subject, that micro-organisms do not occur in the tissues of healthy animals.

In our article on sepsis, reference is made to the experiments of Rosenberger, Rossbach, and Zweifel, who concluded that micro-organisms were present in healthy tissues. Hauser commences his article by refuting these views, and separately demonstrates in detail how they all are based upon experiments performed with insufficient antiseptic precautions, which are therefore not convincing.

The experiments consisted principally in procuring substances prone to fermentation, as parts of organs, blood, urine, etc., in a pure condition, and preserving them unfermented for long periods of time, simply by protecting them from infection, by means of simple cleanliness (sterilized apparatus), not by disinfectants. He preserved the substances in rarefied air, in atmospheric air filtered through cotton, in hydrogen, oxygen, and carbonic acid gas, in water, and in various artificial culture-soils, all under the most favorable conditions for putrefaction, but without any such action occurring. In this manner he could positively prove that living tissues of animals contain no bacteria or germs of micro-organisms whatever; since it is well known that the slightest contamination with substances containing such microbes makes it impossible to preserve organic matter from fermentation and putrefaction. Besides the observation that living tissues contained no micro-organisms, the author found that the preserved organs in time underwent a sort of regressive metamorphosis similar to that which takes place in the body in the absence of micro-organisms, and, what is of especial interest, that the products of such processes of resolution possess no poisonous properties whatever.

W. W. VAN ARSDALE.

* Fortschritte der Medicin, vol. i., p. 661.

† Virchow's Arch., vol. xcii., p. 217.

‡ Fortschritte der Medicin, vol. iv., p. 25.

§ G. Geisler, Jahrb. f. Kinderheilk, vol. xxiii., p. 37.

‖ Ueber das Vorkommen von Micro-org. im lebenden Gewebe gesunder Thiere. Arch. f. experiment. Pathol. u. Pharm., vol. xx., pp. 162-202.

REINJECTION OF BLOOD.

By A. G. MILLER, M.D., Edinburgh.

IN a case of strumous disease affecting both hips, the left knee, and the left elbow, with a large abscess connected with the left hip, the patient being in very feeble condition, amputation at the latter joint became necessary. The limb having been exsanguinated to the middle of the thigh, and a powerful elastic tourniquet applied at the groin, a rapid circular cut was made right down to the bone in the upper part of the thigh, the femur sawn through, the femoral artery and some smaller vessels tied, and the tourniquet removed; some hemorrhage still occurring from a few small vessels, they were also ligatured. All the blood which escaped, both from the femoral artery and the smaller vessels, amounting to eleven ounces, was caught in a vessel containing a solution of phosphate of soda, and reinjected into the deep femoral vein. By an incision on the outer side of the thigh, the head of the femur was then dissected out. The wound was dressed antiseptically. The patient suffered no shock whatever, nor depression of temperature after the operation. For the first few days he was flushed, and had a fuller pulse than before the operation, but he had no rise of temperature. The weakness and the anæmia of the patient, together with the increased vascularity of the parts due to the disease, rendered it very likely that he would not have survived the operation, had not the greater part of the blood lost been reinjected; the fact being that from the exsanguification of the leg, together with the reinfusion, there was probably an ultimate gain of blood after the operation.

J. E. PILCHER, U. S. Army.

—*Edinburgh Med. Jour., Feb.*, 1886.

ZINC IN DRIED APPLES.

ACCORDING to Stinde (*Industrieblatter*, 1886, p. 116) American dried apples often contain zinc. This objectionable impurity is introduced through the operation the apples have to undergo previous to being dried. This consists in immersing them, while contained in zinc baskets, in a solution of salt, whereupon they are at once transferred to the drying hords, which likewise consist of zinc. By washing the sliced apples with brine, they are preserved from turning brown. The whiter, therefore, their appearance, the more advisable it seems to test them for the presence of zinc.—*Dingl. Polyt. Journal.*

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